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PRACTICAL SURGERY:

INCLUDING

SURGICAL DRESSINGS, BANDAGING, FRACTURES, DISLOCATIONS, LIGATURE OF ARTERIES, AMPUTATIONS, AND EXCISIONS OF BONES AND JOINTS.

BY

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SECOND EDITION,

REVISED AND ENLARGED,

WITH

FOUR HUNDRED AND NINETY ILLUSTRATIONS.

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(In Memoriam.)

TO

SAMUEL D. GROSS, M.D., LL.D. CANTAB.,
LL.D. EDIN., D.C.L. OXON.,

PROFESSOR EMERITUS OF SURGERY IN JEFFERSON MEDICAL COLLEGE,

WHOSE EMINENT SERVICES

AS

AUTHOR, TEACHER, AND PRACTITIONER

CONFERRED

HONOR UPON HIS COUNTRY, HIS PROFESSION, AND HIMSELF,

This Book

IS GRATEFULLY INSCRIBED

BY

THE AUTHOR.

PREFACE TO THE SECOND EDITION.

The author desires to express his appreciation of the favor with which the first edition of his work was received by both Practitioners and Students of Medicine.

In the preparation of the present edition, he has endeavored, by the addition of new, and the revision of the original matter, to extend its usefulness.

To the illustrations, for which acknowledgment was made in the preface to the first edition, he has added many others reproduced from the works of GROSS, AGNEW, STEPHEN SMITH, CHEYNE, MACCORMAC, PILCHER, HAMILTON, and GRAY.

Messrs. Gemrig and D. W. Kolbé & Son, of this city, and Tiemann & Co., of New York, have again placed him under obligations for the loan of cuts of splints and instruments.

PHILADELPHIA, 1429 WALNUT STREET,
October, 1885.

PREFACE TO THE FIRST EDITION.

THIS book has been written in response to the request of students who have been from time to time under the instruction of the author, and who have expressed a desire for a work which should embrace in a condensed form the subjects herein treated of. It has been the endeavor of the author to present these subjects in as concise a manner as possible, and at the same time to omit nothing which might be deemed necessary to render the instruction complete. While he has aimed to embody chiefly the results of his own experience as a teacher and as a practitioner, he has not hesitated to make use of the standard text-books on surgery and of such works as are devoted to the consideration of the special topics presented in this.

With a few exceptions, the illustrations are reproductions from the works of GROSS, H. H. SMITH, STEPHEN SMITH, ASHHURST, PACKARD, MAUNDER, HEATH, BELLAMY, and BERNARD and HUETTE. The anatomical relations of the arteries are largely those which are given in "Gray's Anat-

omy," the correctness of which has been verified by dissections and operations.

Messrs. Gemrig and Kolbé, instrument-makers, of this city, and Messrs. Stholmann, Pfarre & Co., of New York, have placed the author under obligations for the loan of cuts of instruments.

To Dr. John W. Barr his thanks are especially due for valuable aid in correcting the proof of the work.

Philadelphia, 1429 Walnut Street,
October, 1878.

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PRACTICAL SURGERY.

Practical Surgery may be divided conveniently into two parts: First, that part which relates to the preparation and application of surgical dressings—mechanical; and, second, that which embraces surgical operations—the use of cutting instruments and the production of wounds—operative.

PART I.

SURGICAL DRESSINGS.

Under this term may be included all appliances which are employed in the treatment of wounds, made either by the surgeon in performing operations, those which are caused by injuries, or those conditions which are the results of morbid processes.

They consist, in general, of Compresses, Plasters, Poultices, Bandages, and Splints, and are prepared in such manner as to fulfil the indications presented in each individual case.

Compresses are folded pieces of various materials, such as lint, charpie, cotton, wool, oakum, muslin, linen, etc., which are placed upon a part and retained by means of bandages.

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Lint is a soft, flocculent substance prepared by scraping the surface of a piece of old linen. That known as patent lint is made by machinery. Recently another form of lint, made from paper and called paper-lint, has been prepared, which possesses remarkable absorbent properties. Lint, rendered antiseptic by boracic acid and other agents, is also found in the shops.

Charpie.—This consists of a mass of loose short threads, made by separating pieces of linen or muslin measuring four or five inches square. It may be either fine or coarse, according to the character of the material employed. It can be arranged into a variety of forms, so as to be adapted to the various kinds of wounds; these are called tents, pledgets, etc.

Cotton-wool.—In the raw state or arranged in sheets, this material is used as a dressing. In this respect, its value has been increased recently by the introduction of various processes which are employed to render it antiseptic, and give to it absorbent properties. It can be made *hygroscopic* by boiling it in lye. In addition, cotton charged with boracic acid, carbolic acid, benzoic acid, subsulphate of iron, perchloride of iron, tannic acid, corrosive sublimate, iodine and iodoform, forming the borated, carbolated, benzoated, hæmostatic or styptic, tannated, corrosive sublimate, iodized and iodoform preparations are now employed largely in surgical dressings. Absorbent cotton takes up fifteen times its weight of water. When the cotton-wool, which has not been rendered antiseptic, is used, care should be taken to see that it is clean and free from particles of dirt. The eggs of the fly are sometimes deposited in it, and under the action of the heat developed when in contact with the surface of the body these develop into maggots.

Wool.—Finely carded wool has been employed as a dressing; it possesses no advantage over cotton, and is more expensive.

Oakum.—This material is made by untwisting and separating pieces of old tarred rope; it is subsequently cleaned, and forms an excellent dressing; is cheap, readily obtainable, and possesses decided advantages by virtue of the tar it contains. Oakum has been rendered antiseptic in the same manner as cotton, forming various preparations.

Jute.—A substance resembling hemp. It is prepared for use as a surgical dressing by cleansing it thoroughly, and then treating it with carbolic acid, resin, glycerin, and alcohol, in the following proportions: To each pound of jute add carbolic acid $2\frac{1}{4}$ ounces (50 gram.); resin, $6\frac{1}{2}$ ounces (200 gram.); glycerin, $8\frac{1}{4}$ ounces (250 gram.); and alcohol, $18\frac{1}{4}$ ounces (550 gram.). In order to reduce the cost of preparation, benzine can be substituted for the alcohol. It has the power of absorbing from four to six times its weight of water. It should be soft and silky, and free from coarse fibres. As the carbolic acid disappears rapidly from it, that used should be freshly made. It retains corrosive sublimate for a longer period. Sublimated jute is made by macerating twelve hours in a solution of corrosive sublimate 1 to 1000 parts of water, and glycerin 50 parts. It serves in general the same purpose as oakum.

Tenax or *Tow.*—A preparation of flax or hemp is also used as a dressing; it is not as available as oakum.

Gauze.—This material is now used much as a dressing, owing to its porous character, which permits of the free escape of discharges from the surfaces of wounds. Dairy or cheese cloth is usually selected, and it is rendered antiseptic by different agents, as carbolic acid, boracic acid, corrosive

sublimate, iodoform, etc. Its cost is so slight that it can be used as a substitute for the ordinary dressings. Mosquito netting, which has not been dyed, can be used in place of the cheese cloth if desirable.

Glass-wool.—This substance consists of finely spun strands of glass, and has been suggested recently as an article of dressing. Its place can be supplied by other dressings.

Peat.—This substance possesses great absorbent properties. It was first employed mixed with iodoform as a dressing in the hospitals at Kiel, in Germany; two varieties, the white and black, are used; sometimes they are mixed, four parts of the former to one of the latter. It is said to absorb sixteen times its weight of water.

Wood-wool.—This substance is obtained from the pulp of wood during the process of paper manufacture. It possesses great absorbent qualities, and is used in the same manner as peat.

Moss.—The ordinary moss of the forests, introduced by Dr. Weir, of New York. It should be dried in an oven to kill the insects it may contain, and can then be treated and used in the same manner as jute, peat, and the wood-wool.

Sawdust.—Dr. A. G. Gerster, of New York, has employed sawdust, which has been soaked in a solution of corrosive sublimate (1 to 500) and afterwards dried, and has found that it gave great satisfaction as a dressing.

Bran.—This substance has been long used as a dressing in compound fractures. Recently it has been rendered antiseptic by carbolic acid, and in this way its value has been increased. It can also be treated with a solution of corrosive sublimate.

Dry Earth.—Clay dried and finely powdered was introduced by Dr. Addinell Hewson, of Philadelphia, as a dress-

ing some years since. It has also been treated with carbolic acid and corrosive sublimate solutions.

Charcoal.—Charcoal in the powdered state has been long employed as a wound-dressing.

Sand.—Kümmell, of Hamburg, has recently introduced this substance as a dressing, using for that purpose white quartz-sand. It is prepared by passing it through a fine sieve, and then heating it in an oven in a covered pan for several hours. Sublimated sand is prepared by mixing 10,000 parts of sand in 10 parts of corrosive sublimate and 100 parts of ether, and should be kept in glass-stoppered bottles. It is used to fill wound cavities, being covered with the sublimated gauze, which is held in place by a gauze bandage.

Coal-ashes.—The absorbent properties of finely sifted coal-ashes render them serviceable for the purpose of dressings. Their antiseptic power can be increased by saturating with an antiseptic solution, as corrosive sublimate. Kümmell has employed the ashes in the shape of cushions, which are of varying sizes, to adapt them to different wounds, and are wet with the antiseptic lotion before being applied.

Spongio-piline is made by felting together layers of lamb's wool and sponge, and coating one of the surfaces with rubber, which renders it impermeable to moisture. This is an elegant preparation, but too expensive for general use.

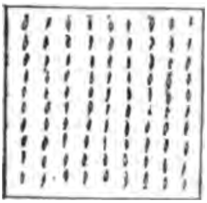
Muslin and *Linen.*—Pieces of old muslin or linen are most frequently used as articles of dressing, and are frequently quite as serviceable as the more costly materials.

The various articles of dressings can be formed into different shapes, as the square, oblong, triangular, cribriform, or graduated compress, the Maltese cross, etc. The forma-

tion of the square, oblong, and triangular compress is quite easy, the name indicating the form.

The *Cribriform Compress* is made by folding a square piece of muslin four or five times on itself, and then nicking the border in a number of places with the scissors. When opened, it will present a cribriform appearance. The openings which are made permit the free escape of discharges (Fig. 1).

Fig. 1.



The *Maltese Cross* derives its name from the shape, and is made by folding a square piece of the material from which it is to be formed into an oblong square, folding this into a smaller square, then into a triangle so as to bring the free edges in contact, and slitting the base of this triangle to two-thirds of its extent, the incision beginning at the end formed by the joining of the free edges (Fig. 2). On opening the piece it will be found that a regular Maltese cross has been formed (Fig. 3).

Fig. 2.

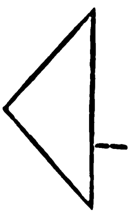
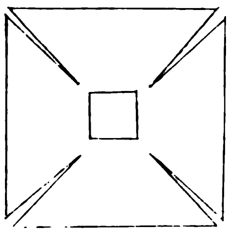


Fig. 3.



The *Half Maltese Cross* is formed by folding an oblong square into a smaller square, then into a triangle, and incising the base as above described (Fig. 4).

These forms are useful in dressing stumps after amputations.

The *Graduated Compress* consists of a number of folds, so arranged that each succeeding fold covers about one-half of that preceding it (Fig 5).

Fig. 4.

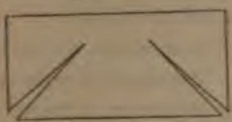


Fig. 5.

The *Pyramidal Compress* is prepared by sewing together square pieces which gradually decrease in size, so placed as to form a pyramid (Fig. 6). These are used for making pressure.

Fig. 6.

It is frequently desirable to cover dressings with an impermeable covering, so as to retain moisture or prevent the escape of discharges upon the bedclothes or clothing. Among these articles are oiled silk, waxed paper, oiled paper, and gum tissue or rubber cloth.

Oiled Silk is made by coating pieces of silk with layers of boiled oil, containing the oxide of lead to render it dry. This was formerly much employed; lately it has been supplanted largely by less expensive articles.

Waxed Paper.—This can be readily prepared by passing sheets of strong tissue paper through melted white or yellow wax or paraffin, and then hanging them up to dry. It serves

the same purpose as the oiled silk, is quite inexpensive, and can be thrown away after being used. A few drops of linseed oil added to the melted wax will render the coating less brittle.

Oiled Paper is made by brushing sheets of paper with boiled oil, which has been reboiled with oxide and acetate of lead, sulphate of zinc, and burnt umber.

Gutta Percha or *Gum Tissue* is a light and elegant article, and is in general use in the antiseptic dressings.

Rubber Cloth.—This material, prepared in very thin sheets, may be employed as an impermeable covering.

Plasters.— *Adhesive Plaster* (Emplastrum Resinæ). This plaster is found already prepared in the shops, spread upon cotton, twill, or swans' down. Care should be taken to select that which has been recently made; when old it becomes dry, cracks, and loses its attachment to the cloth upon which it has been spread.

In cutting strips, the scissors should be applied with the *blades very slightly open*, using the cutting edges of the points only, and dividing the plaster *lengthwise*, and not *crosswise*. The division should be effected by pushing the scissors along, and not by closing the blades, the piece being firmly held by an assistant (Fig. 7). If cut crosswise, the cloth stretches, and thus interferes with proper application of the strips. The width and length of the strips will vary according to the wants of each case; as a rule, they should be three-quarters of an inch wide, and long enough to extend three inches beyond the edges of the wound. In applying them, they should be placed first in contact with the central and the most dependent part of the wound, in order to draw it up and afford support from below upward. Small

triangular pieces may be cut out of the strips at the points of contact with the surface of the wound, so as to permit the discharge to escape. The strips may be made to adapt themselves smoothly and evenly to a round or irregular surface by nicking the edges. Before applying the strips of plaster, it is necessary that they should be heated, and the most efficient, and, at the same time, most convenient method is to place the cloth side of the strips in contact with the surface of a tin can or bottle containing hot water; in this way the surface is equably heated and softened, so as to adhere to the skin. Attempts to heat adhesive strips over the gas-light, candle-light, spirit-lamp, over the surface of the stove, by dipping them in hot water, or by applying such an agent as chloroform, usually result in failures to secure that equable heating and softening of the adhesive surface which is so desirable in securing a firm attachment to the surface of the skin; besides, the strips are liable to be scorched and discolored, and thus detract from the neat appearance of the dressings.

Fig. 7.

In order to remove the adhesive strips, warm water should

be applied to the surface by means of a sponge or cloth. The ends should then be taken hold of, and the strip gently raised from each side of the wound to within an inch of the line of the incision (Fig. 8). The edges of the wound should

Fig. 8.

now be supported by the thumb and index finger of one hand, while the strip is lifted in a vertical direction from the part. Sufficient space should always be left between the strips to permit free escape of the discharges.

In order to avoid giving pain to patients, and disturbing the wound in removing the strips of plaster from surfaces, especially those which are covered with hair, the late Mr. Callender, of London, employed the simple expedient of cutting out the spaces over the dressing at the points the strips left the wound and passed on to the surface of the skin. In renewing the dressing the divided plaster is rejoined by strips laid over the first applied; this can be repeated, leaving the strips first applied still adherent to the skin until the wound is healed.

A very good form of adhesive plaster has been introduced

recently, which is "self-adhesive." The heat of the body is sufficient to render it firmly adherent. It comes in sheets or in strips of various lengths and widths rolled on spools, and is thus prepared very conveniently for use.

Besides the officinal adhesive plaster, other varieties are employed, such as *Isinglass Plaster*, *Court Plaster*, etc. These require to be moistened, and not heated, in order to be made to adhere to the surface, and are more desirable applications in wounds of the face and head.

Poultices, or **Cataplasms**, are soft, moist substances which are employed in the treatment of wounds (Fig. 9). They are designated as the emollient, astringent, stimulating, fermenting, rubefacient, narcotic, etc.

Fig. 9.

The *Emolient Poultice* is that form most commonly used, and may be made of bread and milk, corn meal and water, flaxseed meal, ground elm bark, or any unirritating substance. The flaxseed or linseed meal poultice is made thus: A quantity of recently ground meal is put into a basin which has been *scalded*, and *boiling* water is poured into it gradually, the mixture being well stirred, until it acquires a consistence which will prevent its running out when the basin is inverted. It is then to be spread with a spatula or table knife, to a thickness of one-quarter to three-quarters of an inch, upon a piece of strong muslin of the proper size, a border of an inch in width being left uncovered. The corners of the cloth are now incised with the scissors, and the borders folded over so as to form a margin,

which will prevent the adhesion of the edges to the surface, and also the escape of the contents of the poultice. A piece of fine white gauze or mosquito netting (that which has been dyed should not be used) may be placed over the poultice to prevent it from adhering, and folded down with the edges of the cloth. A few drops of olive oil may be poured over the surface to soften it, or any article with which it is thought desirable to medicate the poultice, as tincture of opium, etc.

In order to retain the moisture in the poultice, it should be covered with a piece of oiled silk, or with waxed paper. As a rule, poultices should be renewed twice in twenty-four hours—more frequently if the conditions of the case demand it.

The *Astringent Poultice* can be made by adding the astringent substance to the linseed meal or bread and milk poultice.

The *Stimulating Poultice* may be made of various substances, as grated boiled carrot, horseradish, garlic, black pepper, brine and corn meal, etc.

The *Fermenting Poultice* is usually made by mixing corn meal with yeast or porter.

The *Rubefacient Poultice* is made by mixing flour of mustard with water until a proper consistence is obtained. Its strength may be reduced by the addition of flour, in the proportions of one-quarter or one-half. Vinegar should not be used in preparing these poultices, as it destroys their rubefacient properties.

A poultice of great value in the treatment of cases of hospital gangrene may be made of equal parts of powdered animal charcoal and brown sugar.

The Iceland moss instantaneous poultice has been lately

introduced, and is found for sale in the shops. It is claimed to possess special advantages in not undergoing fermentation and in the ease with which it can be saturated with medicated lotions.

Poultices may be confined to the part by a few turns of a roller or by broad strips of adhesive plaster. When applied to such a part as the breast, they should be cut in a circular form and the circumference nicked to the extent of an inch or more in order that they may adapt themselves to the surface.

Methods of Irrigation.—It is frequently necessary, in the treatment of surgical affections, to apply water dress-

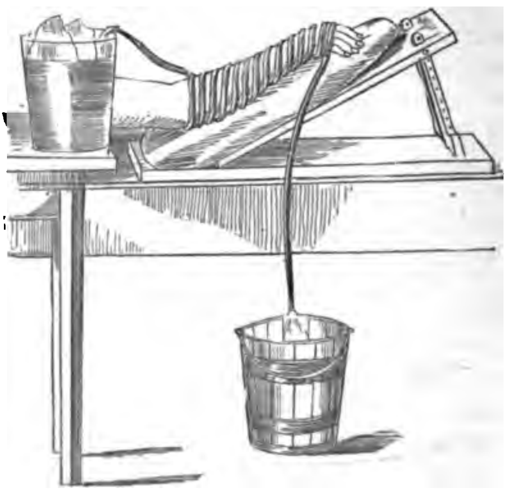
Fig. 10.

[redacted]

ings, or heat or cold either in the dry or moist form. The simplest method in the moist form is to apply compresses wrung out in warm or cold water; this is inconvenient, however, and does not secure a uniform effect. A simple and efficient plan is to put a piece of lamp-wick or a number of threads into a reservoir of water placed some distance above the level of the patient's body, which, acting as a siphon, conveys the fluid uniformly over the part.

Dry cold and dry heat may be conveniently applied in the form of the rubber bags or thin metallic boxes—containing in the one case ice, and in the other hot water. The most efficient method of applying dry cold or heat is by

Fig. 11.



means of the rubber tubing as suggested by M. Petitgand. A flexible rubber tube sixteen to twenty feet in length and one-half of an inch in diameter is applied around the part in a spiral manner and held in position by a few turns of a roller or by adhesive strips. The walls of the tube should be not more than a line in thickness, and the end which is placed in the reservoir should have a metallic cap heavy enough to sink it, and so arranged that the water can have free access to the tube. The other end should be provided with a stopcock and nozzle, so that the flow of the water through the tube can be regulated. The reservoir of water is placed above the level of the patient, as in the other forms. In all cases where water-dressings are employed, the bed should be protected by a rubber cloth or other suitable material (Figs. 10 and 11).

Sponges.—These play an important part in all surgical operations and in the dressing of wounds. They should be selected with great care, and none but those which are of fine and soft texture should be used. When obtained in the shops, it will be found that, as a rule, they contain particles of sand and sometimes other foreign substances. Before using, therefore, they should be thoroughly beaten, washed, and allowed to soak for a number of hours, if practicable. When the calcareous particles cannot be entirely removed by washing, the sponges should be placed for a short time in a dilute solution of hydrochloric acid, one part to thirty of water, which will dissolve the particles, and then washed in an alkaline solution (aquæ ammoniæ fort., ℥ij to Oj of water) to neutralize any acid remaining in the meshes. Sometimes sponges contain *prickles* derived from plants which grow in contact with them, and with which they become

thoroughly impregnated during the process of cleaning and preparing for market. During the use of these sponges the prickles penetrate the fingers of the surgeon, and must, of course, cause much irritation of the wounded surfaces upon which the sponges are placed in operations; care should be taken to reject all sponges containing these substances. It is of great importance that they should be perfectly free from all foreign matter, and should be made *scrupulously clean* before using. It is a good and safe rule to have *new* sponges for each patient, which will be used only for that person. When new sponges cannot be procured, those which have been used can be thoroughly cleansed by soaking them in a four per cent. solution of permanganate of potassium, then in a twenty-five per cent. solution of sulphurous acid, and finally washing thoroughly in water; or, they may be well washed in a solution of carbolic acid (1 to 20), or of corrosive sublimate (1 to 1000) and kept constantly in the solution. Under no circumstances should sponges which have been employed in dressing erysipelatous or gangrenous wounds, or those of a contagious character, be used in dressing the wounds of another patient. If this precaution be neglected, the gravest consequences may ensue in the conveyance of infectious diseases.

In dressing a wound the sponge should never be placed in contact with the granulating surfaces. The water should be allowed to flow upon the surfaces by compressing the sponge raised some distance above. About the edges of the wound and adjacent surfaces the sponge should be applied *gently*, so as to remove discharges. When operations are performed in connection with the cavities of the body, or in cases of necrosis, the sponges should be counted *before* the operation

and *after its completion*, in order to avoid the grave error of leaving any, or pieces of any, in the cavity. Fatal results have resulted and heavy damages have been paid on account of failure to attend to this injunction.

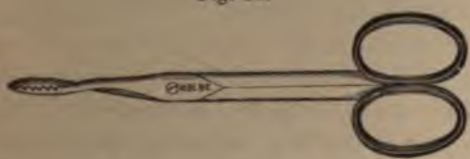
In using the sponges in operations they should be *thoroughly squeezed out* so as to absorb readily the blood, and should be pressed upon the denuded surfaces and not *rubbed.* They should never be used for removing the blood from the floor after operations, or for any purpose other than that for which they were intended.

INSTRUMENTS USED IN DRESSING WOUNDS.

The instruments which are usually required in applying or removing dressings are few in number, and consist of a pair of Dressing Forceps, Dissecting Forceps, and Scissors.

The *Dressing Forceps* are shaped like the ordinary scissors, terminating in rounded, spoon-shaped ends, the edges and inner surfaces of which are serrated. They are used to seize hold of dressings and remove them from the surface of wounds (Fig. 12).

Fig. 12.



The *Dissecting Forceps* are employed to remove minute pieces of dressing, foreign bodies, etc., doing this more readily than the dressing forceps (Fig. 13).

Fig. 13.

The *Scissors* may be either straight or curved, and are used to give shape to the articles of dressings, etc. They should not as a rule be used to divide the tissues, as they produce a contused edge in the wound which interferes with the union (Figs. 14, 15).

Fig. 14.

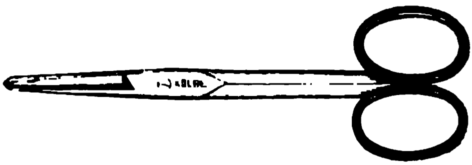
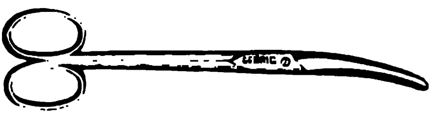


Fig. 15.



These are found in the Pocket Case, with other instruments which are used in operations and in the treatment of disease (Fig. 16).

As it is quite desirable to have the Pocket Case small in size and not too bulky, and yet contain all of the instruments required, some tact has been displayed in arranging them. That known as Professor S. D. Gross's case con-

tains: One Scalpel and Straight Bistoury; two Curved Bistouries, probe and sharp-pointed; one Tenotome and Tenaculum; one pair of Artery and Needle Forceps combined; one pair of Scissors; one pair of Polypus and Dressing Forceps; one pair of Dissecting Forceps; one Exploring Needle; one male and female Catheter; one Porte-caustique; one Gross's Ear Instrument; one Grooved Director; one pair of Probes; one half-dozen Needles, and one skein of Silk. The cutting instruments are double-bladed, with slide

Fig. 16.

locks to secure the blades, either opened or closed (Figs. 17, 18). Dr. W. W. Keen has suggested a modification of

Fig. 17.

Fig. 18.

the pocket case which materially reduces its size, and at the same time adds three instruments. As arranged by him it measures $4\frac{1}{2}\times 2\frac{1}{2}\times 1\frac{1}{8}$ inches, and contains in addition a hypodermic needle, a thermometer, and a tubular needle.

DRESSING A WOUND.

In order to dress a wound the following articles and instruments should be at hand: Water, both hot and cold;

receptacle for the soiled dressings, basins, sponges, lint or other material to form compresses, syringes, including a fountain syringe, rubber-cloth to protect the bed, towels, bandages, adhesive plaster, tin can containing hot water to heat the plaster, needles, pins, and pocket case containing dressing forceps, dissecting forceps, and scissors.

A sufficient number of assistants should always be present, in order that the dressings may be removed and applied with as little delay as possible. Usually three are required: one to support the part, one to attend to the sponges and supply of water at proper temperature, and a third to hand the dressings and instruments. Before exposing the wound, the assistants should be assigned to their respective positions, the dressings prepared, and everything in readiness. The rubber cloth should be placed so as to protect the bed, and the part lifted by the assistant and held in a comfortable and easy position. The soiled dressings should be removed carefully and placed in a covered receptacle and taken from the room. The wound should be cleansed by allowing the water to flow over it, from the tube of the fountain syringe, or squeezed out of a sponge held some distance above its margin, or vertically over it. If cavities exist, these can be thoroughly cleansed by throwing water into them with a syringe, being careful to avoid giving too much force to the stream. The borders of the wound and adjacent surfaces should be gently wiped with the sponge, with *regular and even motions*, carrying it *toward the edges* so as not to cause them to separate or to pull upon the sutures if they still remain. Short, jerking movements should be avoided in using the sponge, as they give pain and are liable to cause separation of the edges of the wound. The sponge should not be placed in contact with the denuded surfaces. Collections of

pus can be removed by a gentle stream of water thrown by the syringe, and foreign bodies can be picked off readily with the dissecting forceps.

When cleansed, the borders should be dried by pressing a clean, soft towel upon them, care being taken to avoid bringing it in contact with the wound. If required, the adhesive strips already cut should be applied in the manner directed above (page 21). The compress, upon which has been spread the cerate or substance employed, is placed over the wound, and held in position by turns of the roller or broad adhesive strips.

The more important points in applying dressings, to which the attention of the student is directed, may be expressed in a few general rules:—

I. The position of the patient should be that which is most comfortable and free from restraint. The bed or table should be placed so as to afford ample light and space to those engaged in the dressing.

II. Every article required in the dressing should be prepared and arranged before the wound is exposed. They should be placed in order, so that they can be easily and quickly reached.

III. The removal of the old dressings, the cleansing of the wound, and the application of the new dressings should all be performed in such manner as to avoid giving unnecessary pain to the patient. Every movement of the surgeon and assistants should be made with care — rough handling of the patient or of the wound should not, under any circumstances, be permitted. If the removal and application of the dressings cause great pain, the patient should be placed under the influence of an anæsthetic agent.

IV. The wound should be exposed for as short a time as

possible. Renewal of the dressings, unless the discharge is excessive, is not usually required oftener than once in twenty-four hours. Frequent dressings disturb and expose the wound, and thus interfere with the process of repair.

V. The fingers should not be used in removing the dressings or foreign substances from the wound, lest disease should be thus conveyed from one to another patient, or the surgeon become infected by the discharges.

VI. The hands of the surgeon and assistants should be carefully washed both before and after the dressing.

VII. All of the instruments used should be kept *scrupulously clean.*

THE ANTISEPTIC SYSTEM OF DRESSING WOUNDS.

The System of Lister.—This is a system introduced by Sir Joseph Lister, who defines it as "the dealing with surgical cases in such a way as to prevent the introduction of putrefactive influences into wounds."

The following articles are necessary in order to properly carry out the antiseptic method in surgical operations and dressings :—

1. *Two solutions of carbolic acid,* 1 in 40 (twelve grains to the ounce), and 1 in 20 (twenty-four grains to the ounce), should be prepared,—the first for the protective and loose layer of gauze, the second for the spray, and in which the sponges, instruments, and drainage tubes are immersed, and also which is used to wash the part and the hands of the surgeon and assistants.

2. *Steam Spray Apparatus.*—This consists essentially of a spirit lamp with a hollow wick, a boiler to contain water, a bottle to hold the solution of carbolic acid (1 in 20), and a

spray-tube. An excellent and inexpensive apparatus has been devised by Dr. R. F. Weir, of New York (Fig. 19).

Fig. 19.

3. *Antiseptic Gauze.*—This is prepared as follows:—Coarse-meshed cotton cloth, known as dairy or cheese cloth, is heated above 212°, and then sprinkled with its own weight of a mixture of carbolic acid one part, common resin four parts, and paraffin four parts, the latter being melted together in a water-bath, and the acid then added by stirring. Pressure is then applied, so as to disseminate the liquid equally through the cloth. Old mosquito netting, which has been boiled in lye, can be used in place of the dairy cloth. In cases in which it is desirable to economize with regard to the use of the guaze, the larger and least soiled pieces can be washed and re-charged and used in future dressings as loose gauze. The expense of preparing the gauze can also be much reduced by the substitution of

castor oil for the paraffin as practised by Von Bruns, according to the following formula:—

Carbolic acid	1 part
Resin	4 parts
Castor oil	8 "
Alcohol	20 "

The resin is dissolved in the alcohol and then the castor oil and carbolic acid are added by stirring in well. The gauze is simply soaked in this solution and then hung up to dry; in a few minutes it will be ready for use. Benzine may be used in the place of alcohol, still further reducing the cost of preparation. Its purpose is to absorb the fluids from the wound, and to prevent their decomposition.

4. *The Mackintosh.*—This is a material used in the manufacture of hats, and consists of thin cotton cloth with a layer of red vulcanized rubber on one side. Thin rubber cloth, oiled silk, or gutta percha tissue will be found probably as effective. The material used should be free from holes. The Mackintosh is used to compel the secretions to permeate the whole dressing, thus being constantly in contact with the carbolic acid. It is placed between the seventh and eighth layers of the gauze.

5. *Rubber Tubings.*—These are used for drainage, and vary in size from one-eighth to one-half of an inch. Numerous openings, each half the diameter of the tube, are made on the side. Red rubber tubes should be used as they contain no free sulphur. (Fig. 20.)

When introduced into a wound or cavity, the outer end of the tube should be cut flush with the surface of the skin, and should be secured in place by two threads of carbolized silk, fastened into the end and tied in a knot, which can be

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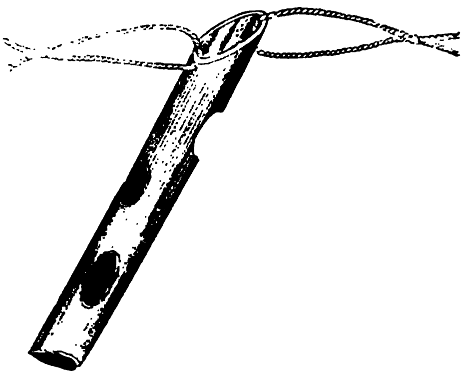
[redacted]

placed between the skin and dressings. In order to obtain greater security strips of gauze wet with carbolic lotion can be inserted between the loops.

Fig. 20.



The tubes should be kept constantly in a large vessel containing 1 to 20 carbolic acid solution. Tubes which are to be returned should not be removed from the wound until the third day, by that time a channel in the lymph has been formed which permits of an easy reintroduction. Before returning, all drainage tubes should be washed with a 1 to 20 lotion of carbolic acid.

In the place of rubber tubes catgut threads and horse hair have been employed. The former were introduced as means of drainage by Mr. John Chiene, and are used as follows: a bundle of the finest catgut threads, fifteen to twenty in number, is tied at the middle by a single thread which is passed through the eye of a curved needle (Fig. 21). By means of this needle the bundle is fastened to the deepest part

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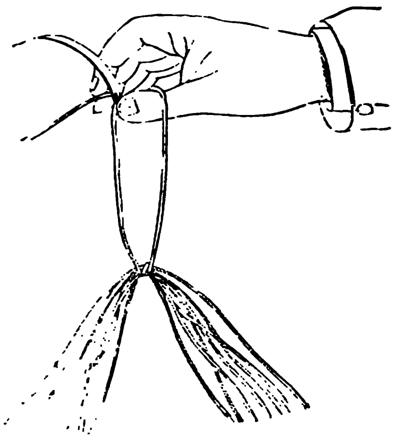
of the wound and three or four smaller bundles, of five or six threads each, are formed which pass out of the wound at the angles and at intervals between the sutures. (Fig. 22.)

Fig. 21.



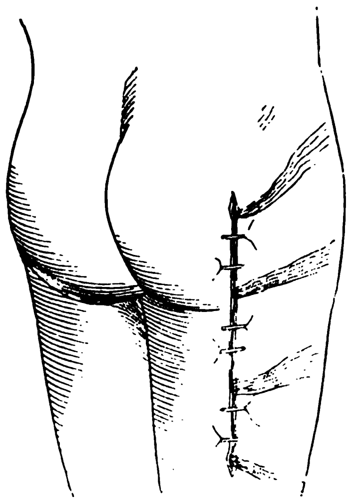
The ends of the threads should be long in order to facilitate the capillary action. In five to six days these ends become detached and the portions within the wound disappear by absorption.

Drainage by bundles of horse hair has been employed with good results especially in joint wounds. The bundles are placed in such parts of the wound as may be requisite. The hairs can be removed one at a time, as the conditions of repair require; they are not absorbable.

Dr. Neuber, of Kiel, has employed decalcified bone tubes in place of rubber. They are made by drilling long bones and cutting holes in the sides, and possess the advantage of

being capable of undergoing absorption. Dr. MacEwen has substituted chicken bones, which are prepared by scraping

Fig. 22.



and immersing in a solution of hydrochloric acid 1 to 5 of water. When sufficiently softened the ends are cut off, the interior cleaned out, and they are re-immersed in the acid solution until they become quite pliable. Holes are cut out of the sides at proper intervals and they are placed in a solution of carbolic acid and glycerine (one-to-ten). At the end of two weeks they may be used. Horse hair is passed through the tubes before introduction into the wound, which prevents collapse of the tube and also facilitates drainage by capillarity.

6. The *Protective* is a piece of oiled silk which is placed over the wound to protect it from the irritating effects of the carbolic acid in the antiseptic gauze. It is prepared by coating it with a thin layer of copal varnish, and then brushing over with a mixture of dextrine one part, starch two parts, and sixteen parts of the one-to-twenty carbolic acid solution.

7. *Carbolized Catgut Ligatures* are made by putting catgut ligatures into a mixture of carbolic acid one part, dissolved in one-tenth its weight of water, and then added to five parts of olive oil. A stronger article of catgut ligature may be obtained by immersing the ordinary catgut for forty-eight hours in a solution formed by dissolving one part of chromic acid in 4000 parts distilled water and adding 200 parts of pure carbolic acid. It is then taken out and dried and put in the one-to-five carbolic oil.

It is important to employ a convenient receptacle in which the catgut can be kept for use. Glass vessels or bottles containing carbolic oil one to five, and holding two or three glass reels upon which ligatures of different sizes are wound, with openings through the lid or with tubes passing through the stopper for the passage of the ends of the ligature, serve the purpose well. Sir Joseph Lister has devised a catgut holder —consisting of a reel placed within a German silver case— it can be carried in the ordinary pocket-case.

8. *Carbolized Silk Sutures* are prepared by placing them in a mixture of melted wax nine parts and carbolic acid one part, and afterward drawing them through a folded cloth to render them smooth. They should be kept in closely stoppered bottles.

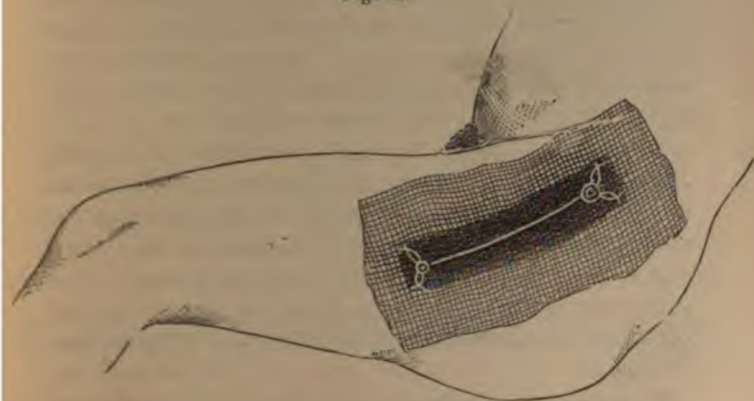
9. *Sponges.*—These are carefully beaten, cleaned, and washed in lukewarm water, and kept in the one-to-twenty

solution of carbolic acid. After use they are cleaned and returned to the solution. Sponges frequently become filled with fibrin during operations. In order to clean them they should be allowed to soak some hours in a solution of carbonate of sodium—one-quarter pound to one gallon of water—during which time the fibrin is dissolved, and can be removed readily by repeated washings. They should be then placed in the one-to-twenty carbolic acid solution.

An operation under the system is performed as follows: Three shallow basins (those which are oblong in shape are more convenient) should be at hand; one containing the one-to-twenty solution to hold the instruments; the second, containing the one-to-forty solution, for the sponges. The hands, and particularly the finger ends, of the surgeon and all of the assistants are to be washed in the third basin, containing a solution of the same strength. The bottle of the spray apparatus is filled with the one-to-twenty solution, and the apparatus set in operation. The surface is washed with the one-to-twenty solution, and the spray directed upon the part. The incision is made, the blood cleared away by the sponges, vessels ligatured with the catgut ligatures, which are cut off short; drainage tubes introduced into the depths of the wound and brought out to the surface at the most dependent part and cut off short, and the wound closed with the carbolized silk sutures. If complete drainage cannot be effected through the wound, a counter opening should be made, and the drainage-tube introduced through it. A piece of the oiled silk protective, which has been kept in one-to-forty solution, of a size to barely cover the edges, is now placed over the wound, then a piece of the gauze in one layer and wet in the one-to-forty carbolic lotion, and of such size as to largely overlap the protective. This consti-

tutes the deep dressing (Fig. 23). The uneven surfaces must be then covered with loose gauze so as to fill up all depres-

Fig. 23.



sions, and the outside gauze dressing, consisting of a piece of suitable size, folded in eight layers, with a piece of Mackintosh with rubber side inwards, between the seventh and eighth, then applied. This dressing is held in position by a bandage, and an elastic bandage is applied around the edges of the dressing to keep them in contact with the surface of the body during movements of the patient. Safety pins are used to secure the elastic bandage to the edge of the dressing.

Wet carbolized towels should be placed over the blankets covering the patient, or near at hand on the table upon which the instruments may be laid, and a towel, wet in the one-to-forty lotion, should be placed conveniently, so as to

cover the wound, in case of failure of the spray apparatus, or to be thrown over a portion while operating in large wounds.

If, during the operation, the spray apparatus fails, the wet towel, called the guard, must be quickly applied over the wound, and kept there until the spray is again directed upon the part. The dressing is, as a rule, renewed in twenty-four hours, and this is done under the spray, the same precautions being taken as in the first dressing. If the piece of oiled silk protective is unchanged in color, the wound is *aseptic*. If it shows dark-brownish spots, which are caused by the action of the liberated sulphur in the pus upon the lead in the oiled silk, the wound is *septic*, and should be washed out with the one-to-twenty solution, or with a solution of chloride of zinc (forty grains to the ounce of water), one part of the solution of the chloride of zinc to three parts of water.

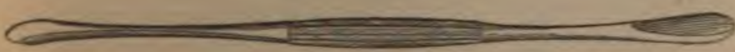
In redressing, everything is renewed except the Mackintosh, which can be washed off with the one-to-twenty solution, and reapplied. The extent of the discharge, the sensations of the patient, and the temperature elevation, are the guides which direct with regard to a renewal of the dressings. If the dressing has been successfully applied, the temperature should be normal or but little elevated. So long as everything is favorable the dressings need not be disturbed, though they should not be allowed to remain in place for more than a week.

In cases of wounds not made by operation, as lacerated wounds, compound fractures, etc., a somewhat different plan of treatment is to be adopted, although the articles of dressing and their method of application are the same. The wound is to be treated as a septic wound, and is to be thoroughly washed out with a one-to-twenty carbolized solu-

tion, or a solution of one part of carbolic acid to five parts of spirits of wine, and then dressed as before described. In cases of suppurating wounds, old ulcers, etc., they should be first swabbed out with a solution of chloride of zinc, forty grains to the ounce, and then dressed with the usual antiseptic dressings.

This plan of treatment has been modified recently in the use of boracic instead of the carbolic acid dressings. All recesses and sinuses should be freely opened up, and the unhealthy granulating surfaces thoroughly scraped by curettes which may be made of different shapes and sizes (Figs. 24

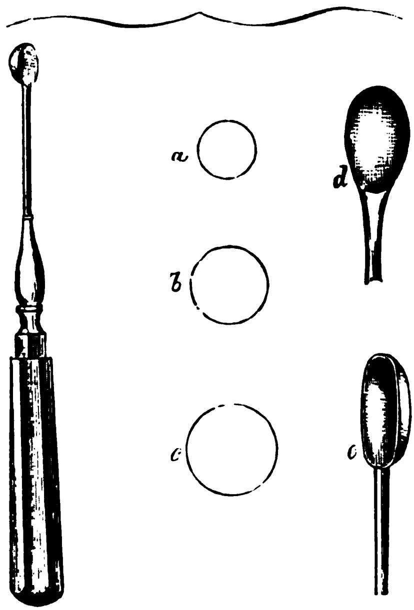
Fig. 24.



and 25), and then purified by washing out with solution of chloride of zinc, forty grains to the ounce of water, and the surrounding skin thoroughly cleansed by washing with the one-to-twenty carbolic lotion. Then the ulcer is covered, as in the former dressings, with a piece of protective which has been dipped in a boracic acid solution, saturated solution in water—one part in thirty parts of cold water; over this is applied a piece of boracic lint of sufficient size, secured in place by an ordinary bandage. In the place of the chloride of zinc solution iodoform has been recently used; it is powdered freely over the surface, and gives no pain, having rather an anæsthetic power. If putrefaction does not cease after one application of the zinc or iodoform, a second may be made. The dressings should be renewed on the second day, but after that an interval of three or four days may be allowed to elapse if the discharge is not

great. In changing the dressing the spray is not required. The boracic lint may be made by soaking ordinary lint in a

Fig. 25.



hot saturated solution of boracic acid, and contains about one-half of its weight of crystals of the acid, and its antiseptic qualities, therefore, last for some time. The borated cotton-wool is made in the same manner. Both the lint and lotion are tinted with litmus to distinguish them from carbolic preparations. The chloride of zinc solution can be used for the purpose of purifying ulcers, sinuses, etc., by

cotton-wool in a solution of six ounces (170 grammes) of salicylic acid, one gallon (3099½ grammes) of alcohol (sp. gr. 0.830) and nine gallons (33 litres) of water at a temperature of 150° F.

The second (10 per cent.) is made by immersing 22 pounds (ten kilogrammes) of absorbent cotton-wool in a solution of 34 ounces (one kilogramme) of salicylic acid, 20 gallons (10,000 grammes) of alcohol (sp. gr. 0.830) and 16 gallons (60 litres) of water.

Salicylated Jute, 3 per cent., is made by immersing 83⅓ ounces (2500 grammes) of jute which has been cleaned, in a solution of 2½ ounces (75 grammes) of salicylic acid, 16⅔ ounces (500 grammes) of glycerine, and 150 ounces (4500 grammes) of water at 158–176° F. (70–80° C.) In this preparation the glycerine holds the salicylic acid in the jute.

In the application of the dressings the solution used for the spray is the 1–300 salicylic acid. The instruments must be placed in solution of carbolic acid, owing to the oxidizing effect of the salicylic acid on the steel. A piece of perforated gutta-percha tissue, covered with a piece of gauze three fingers' breadth in thickness, is placed over the wound. Over this a layer, one finger's thickness, of the 10 per cent. salicylated wool, and two fingers' thickness of the 3 per cent. wool is placed, and all is secured in place by a bandage. If no pain is complained of, the dressing remains in position for eight or ten days, when it is changed to remove the drainage-tube; if any discharge appears through the dressing, fresh wool is applied outside. The second dressing is not disturbed until healing is completed. The protective and Mackintosh are not required.

Thymol.—This agent was introduced some years ago by Ranke, of Halle, as a substitute for carbolic acid. Its use has

been largely abandoned on acount of its very feeble antiseptic properties and of the objections made to its sweetish odor, which produced headache and attracted swarms of flies.

Eucalyptus Oil.—Schulz of Bonn, Germany, has recently suggested the use of this oil as possessing valuable antiseptic qualities, and Sir Joseph Lister has made trial of its virtues in the treatment of wounds. Its odor is pleasant, it is non-poisonous, and unirritating. Preparations of gauze and ointment have been made and have been found satisfactory. A solution can be made, in varying proportions, with olive oil or dissolved in alcohol.

Acetate of Alumina.—Quite recently the acetate of alumina has been suggested by Prof. Maas, of Freiburg, he claiming that with a 2.5 per cent. solution he obtains aseptic results. A protective is applied over the wound and over this compresses soaked in the solution, the whole dressing being covered by an impermeable tissue. The dressings require to be removed at rare intervals.

Aceto-tartrate of Alumina has been introduced as an antiseptic by Kümmel, of Hamburg. It is used in ½ to 3 per cent. solutions and mixed with charcoal, three parts of the salt to seven of baked charcoal. This form of dressing may remain undisturbed for one or two weeks.

Iodine.—This agent has been long employed as a topical application. Mr. Bryant has used a solution of iodine and water in the proportion of twenty drops of the tincture to one ounce of water to wounds for the purpose of checking hemorrhagic oozing, and for purification of the surfaces.

Iodoform contains ninety-six per cent. of iodine, and is a much more eligible preparation. As an antiseptic dressing its use was first recommended by Prof. Von Mosetig Moorhof of Vienna. While it is quite soluble in ether and the

oils, less so in alcohol and water, it is best used in the form of the powder and the iodoformized gauze. The "absorbent iodoform gauze" is prepared by rubbing into the meshes roughly the powder of iodoform. The loose gauze is placed in a basin which has been washed out with carbolic lotion and freely sprinkled with iodoform powder, a pepper box being used for that purpose. The powder is worked in with the hands until the gauze is of a uniform yellow color. The excess is shaken out and the gauze, now ready for use, is put in sealed glass jars. It contains from 10 to 20 per cent. of iodoform. Adhesive iodoform gauze is made by soaking gauze in a solution of resin 100 parts, alcohol (95 per cent.) 1200 parts, and glycerine 50 parts, and then dusting iodoform upon the surface after it has been wrung out and partially dried. This form contains nearly four times more of iodoform than the ordinary gauze. Iodoformized cotton-wool may be used, and is prepared by soaking in the following solution: Iodoform 50 parts, ether 250 parts, and alcohol 750 parts. It may be made extemporaneously by rubbing the powder into the substance and shaking so as to git rid of the excess. Owing to its slight solubility in water, iodoform is not adapted for the disinfection of sponges, instruments, etc., or for application to surfaces which have not been purified by other antiseptic agents, as carbolic acid, corrosive sublimate, etc. Over fresh or purified wounds it may be gently powdered, the wound closed and dressed with several layers of the iodoformized gauze, this covered by gutta-percha tissue, and the whole secured in place by a bandage. In open wounds the surfaces are sprinkled over lightly, the cavity packed with iodoform gauze and the dressing completed as in the fresh wound.

Objections exist with regard to the use of iodoform as a

dressing on account of the odor and of the very decided toxic qualities it possesses. The disagreeable odor can be masked by the use of various agents, as Peruvian balsam, musk, the essential oils, as bergamot, clove, and peppermint, and the Tonka bean. In order to avoid producing toxic effects great caution should be excerised in its use; it has been ascertained by Neuber from the experience he has gained that not more than forty to forty-five grains can be placed safely upon a fresh wound-surface, and this amount cannot be taken as the limit as the susceptibility varies in different cases. The symptoms of poisoning are headache, loss of appetite, wakefulness, the constant taste of iodoform, and, in the severer cases, mental derangement to the extent even of acute mania. The treatment consists in the prompt removal and discontinuance of the dressings, and the use of alcoholic stimulants.

Naphthalin.—This agent is one of the products of coal tar, and was first used as a dressing by Dr. Fischer of Strassburg. It is employed in the form of powder and is applied in the same manner as iodoform. While its antiseptic power is less than iodoform, it possesses the advantage of being free from toxic properties, and can be substituted, therefore, for it. Gauze coverings may be impregnated with it.

Subnitrate of Bismuth.—Finely-powdered subnitrate of Bismuth suspended in water so as to form an emulsion is advocated by Prof. Kocher of Berne as an efficient antiseptic wound-dressing. A one per cent. watery mixture is used for sprinkling over wound surfaces and spread over the line of sutures with a brush after closure of the wound in operations. Gauze which has been immersed in a ten per cent. mixture of bismuth and wrung out is applied, then a layer of cotton-wool covered by gum tissue, and over the

whole a bandage to secure the dressing in place. Toxic effects manifested, it is stated, by the symptoms of acute stomatitis, intestinal catarrh, and desquamative nephritis, have been produced by the use of strong mixtures which are now abandoned, and the excessive application of the powder to cavities. These conditions are transient, and subside after discontinuance of the dressings. The value of subnitrate of bismuth is impaired by reason of its want of control over erysipelas.

Permanganate of Potassium.—This agent has long been in use as a wound-disinfectant in the form of aqueous solutions of 5 to 20 parts to 100. Prolonged antiseptic effects cannot be accomplished by it, owing to the rapid decomposition which occurs when it is brought into contact with organic substances.

Chloride of Zinc.—The chloride of zinc, as is well known, possesses powerful caustic properties, and it has taken part in antiseptic dressings usually in such strengths (40 grains to the ounce) as to secure purification of septic wounds. Dilute solutions, 1 to 500, are advised for washing out large suppurating cavities which are protected against the entrance in the future of septic agents by an external antiseptic dressing. Its action on the tissues interferes with union by the first intention.

Terebene.—This is a product of the oil of turpentine, and is used as a wound application by saturating sponges with it and placing them over the wound. It is stated that Mr. Furneaux Jordan after amputations places one between the flaps and allows it to remain for several hours.

Corrosive Sublimate.—Of all the substances introduced as wound dressings none seems to have met with more general favor than corrosive sublimate, possessing all the advantages

of powerful germicidal properties, ease of application in many forms, and freedom from danger of producing toxic effects, in solutions of efficient antiseptic strengths. It was first used as a wound dressing by Kümmell and Schede in the Hamburg General Hospital in 1881. It has been used in solutions varying in strength from 1 in 100 to 1 in 5000. It has been found that a solution of 1 in 1000 (7½ grains to the pint of water) is in all respects reliable as an antiseptic and free from danger, and therefore it has been adopted as the standard. The articles which are used in the corrosive sublimate dressing are prepared in a very simple manner. According to Dr. Weir, jute and moss are dipped into a solution of corrosive sublimate 1 part to 1000 of water and 50 parts of glycerine. They are soaked in this solution from ten to twelve hours, then wrung out and allowed to dry to the extent permitted by the glycerine. The gauze and cotton-wool are treated in this way. Deprived of oily matters they are immersed in a solution composed of corrosive sublimate 20 parts, water 4480 parts, glycerine 500 parts. A slight aniline tint is given to the gauze to distinguish it. It is desirable that these preparations should be freshly made, as often a slight change occurs owing to the conversion of the corrosive sublimate into calomel. Prof. S. W. Gross finds that the addition of common salt to the solution prevents the change of the corrosive sublimate into calomel, and suggests the following formula :—

Corrosive sublimate 1 part . .	grs. 7½.
Common salt 5 parts . . .	grs. 37½.
Glycerine 10 parts	℥i–gtts. vij.
Water 1000 parts	Oj.

A simple test may be applied to the dressings by the application of a few drops of lime-water ; if this is followed by

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the formation of a yellow spot, corrosive sublimate is present; if by a black spot, calomel has formed.

Sublimated catgut is used both as ligatures and sutures, and is prepared by placing it for ten minutes in 1 to 100 solution; then into a 1 to 1000 for ten to fifteen hours, and afterwards it is wound on glass spools and kept in absolute alcohol, or it may be put in oil of juniper for twenty-four hours, and then in pure alcohol. Silk sutures are immersed for two hours in a 1 to 100 solution of corrosive sublimate, and kept for use in a 1 to 1000 solution.

Drainage-tubes, either of rubber or decalcified bone, are used; in order to prevent the two rapid absorption of the latter, they are kept in pure alcohol which hardens them.

Sponges after being cleaned are kept in the 1 to 1000 solution of corrosive sublimate; preferably in that to which the salt has been added, as suggested by Dr. Gross.

Neither protective nor impermeable outer covering are required in the dressing.

Before an operation the surfaces about the points of incision are scrubbed with soapsuds, and afterwards painted over with an iodoform solution or washed with a solution of turpentine and alcohol, two ounces to the pint, in order to dissolve all greasy matters and to purify the parts. The hands and nails of the surgeon and assistants are publicly and thoroughly washed and disinfected. The instruments, owing to the corroding effect of the corrosive sublimate upon the metal, must be immersed in the 1 to 20 solution of carbolic acid.

If the spray is used, it must be formed from the carbolic acid solution.

In the dressing, bandages, one and a half to two inches in width, made from the sublimated gauze or crinoline, are employed.

During the operation, without the spray, the solution (1 to 1000) is allowed to run continuously over the incision, the patient being protected by a rubber blanket, which is arranged so as to expose only the part operated upon. In order to avoid any danger as to the toxic effects of the solution, Thiersch has suggested the boro-salicylic solution consisting of boracic or boric acid 6 parts, salicylic acid 1 part, and water 500 parts; this is employed during the operation, the wound being finally washed with the corrosive sublimate solution.

After the vessels have been ligatured, and hemorrhage has ceased, drainage-tubes of rubber or bone are put in place, the wound is cleaned and then closed with catgut sutures, using the continued instead of the interrupted suture for that purpose. The interior of the wound is cleaned by injecting the sublimate solution through the drainage-tubes, and the surfaces compressed by several sponges until a piece of sublimated gauze can be applied over the centre of the wound. The pressure being maintained, several layers of the gauze, not too wet, are applied and secured in place by turns of a sublimated gauze bandage. Over the dressings, carried thus far, the absorbent materials are placed, being retained in bags of suitable size and shape. These are from one to two inches in thickness, and may contain peat, wood-wool, or any other substance which may be selected. Those of smaller size are packed about the wound and then covered by a large one, and over all a crinoline bandage wet with the sublimated solution is applied. If the discharge appears upon the surface of the dressing, the parts can be douched with the sublimated solution, and cotton-wool or gauze applied over the part. The dressings may remain in place for several days if no elevation of temperature occurs. In most instances

but one change of dressing is required until healing has taken place.

A dressing, according to this method, may be made extemporaneously by dissolving seven and a half grains of corrosive sublimate in a pint of warm water, dipping ordinary absorbent cotton into the solution, wringing it as dry as possible, and securing it in place over the wound by a bandage wet in the same solution. Drainage can be effected by the introduction of the perforated rubber tubing. This dressing may remain until one more elaborate is prepared if deemed necessary.

Modifications of the Antiseptic Method.—Various modifications of the antiseptic method of wound-treatment have, from time to time, been introduced.

Trendelenburg has published the results obtained by him in operations and treatment of wounds without the use of the spray. During the operation he allowed the carbolic acid solution to run over the wound, and, while filled with the solution, it was closed. At the time of changing the dressing, the same precautions were taken.

The late Mr. Callender, of St. Bartholomew's Hospital, London, employed carbolic acid and olive oil, one to twelve, having first brushed over the cut surfaces a solution of chloride of zinc, forty grains to the ounce of water, or washed the wound with the one in twenty solution of carbolic acid. He then covered the wound with lint saturated in this solution, and surrounded the part with cotton-wool. Hemorrhage was controlled by torsion of the vessels.

Methods of wound-treatment not strictly antiseptic:—

Guérin's Cotton-wool Dressing.—Originally this method, introduced by Alphonse Guérin, consisted in the application of large masses of the ordinary cotton-wool which were firmly secured in place by a bandage, the wound having

been washed out with tepid water. At present the wound is washed out with a carbolic acid solution, and the deep layers of the cotton-wool are wet with the carbolic lotion. Between the layers of cotton the powder of camphor is sprinkled, layer after layer of cotton is applied and very firmly secured with the bandage, so as to make uniform compression. As much as five pounds of cotton have been sometimes applied. Formerly no sutures were employed, but recently, with a view to obtain primary union, they have been introduced. The precautions to be taken in applying this dressing are important: 1. The dressing must not be applied or renewed in the ward, but in a room some distance from it. 2. The cotton-wool should not be opened in the ward, owing to danger of contamination from the air.

The dressing is allowed to remain undisturbed from two to three weeks; if the discharge comes through, the dressing may be washed with carbolic acid solution, and a fresh layer of cotton applied. The object sought to be accomplished by this dressing is to exclude, by filtration, septic agents, and also to maintain elastic compression and constant temperature. It is also claimed that it secures the suppression of pain, absence of traumatic fever, and diminution of suppuration.

The dressing has been modified by M. Ollier, who soaked the deep layers of the cotton-wool in carbolic oil.

Alcohol has been employed as a dressing with good results. The method of Mr. Jonathan Hutchinson is as follows: Hemorrhage having been controlled chiefly by torsion, the wound is washed out with pure alcohol, drainage-tubes inserted, and sutures introduced. Over the wound, thin compresses of lint, soaked in a solution of absolute alcohol six parts, liquor plumbi one-half of a part, and distilled water

sixteen parts, are applied and are kept constantly moist preferably by a drop irrigator. The compresses are changed daily. The alcohol acts as an antiseptic, and primary union is generally obtained.

The Open Method.—This method was first employed by Drs. Bartscher and Vezin, who practised it in the following manner: after the cessation of hemorrhage, the wound is cleansed by washing out with cold water, and, in case of an amputation, the stump is placed on a soft pillow and over it a piece of gauze or linen to keep out the flies. On the next day a clean pillow is placed beneath the limb without any cleansing of the wound being made. No sutures are employed; by this method primary union is not accomplished. Modifications of the method have, from time to time, been introduced. In some the edges of the wound are brought together by sutures or strips of plaster, and antiseptic solutions are used to cleanse the parts. The late Dr. Wood, of New York, employed this method in a number of cases, modifying it, however, by the free use of carbolic acid and devoting great attention to thorough cleanliness.

Surgical Dressing Cases.—Cases, of different sizes, containing all of the agents employed as wound dressings, are to be found in the stores of the instrument makers. Thus provided, the surgeon is enabled to make the primary dressing complete in all wounds the treatment of which he is called upon to conduct.

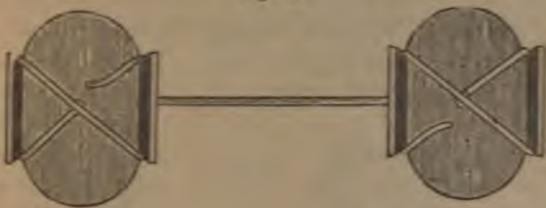
In the treatment of wounds the great object to be attained is to secure if possible primary union, if this is not possible then to employ such means as will facilitate repair with as little delay as possible and with the least drain upon the vital power of the patient.

Certain points of great importance are involved in the

treatment of all wounds, and should always claim careful attention.

1st. Accurate coaptation of the wounded surfaces should, if possible, be always secured. This is accomplished by means of sutures which may be introduced, superficially for the purpose of coaptating the superficial tissues or deeply for the approximation of the deeper tissues; these sutures have been designated respectively as sutures of coaptation and

Fig. 26.



sutures of approximation. There are also other sutures called sutures of relaxation, which are introduced some distance from the margins of the wound for the purpose of relaxing the tissues near the wound and thus preventing tension of the sutures of approximation. (Fig. 27.) The perfect coaptation of wounded surfaces prevents the accumulation of wound fluids and thus contributes to rapid healing. In securing it, however, great care should be observed that it is not accomplished at the expense of producing undue tension, which reacting upon the wounded tissues provokes irritation and induces conditions which interfere with and greatly retard the reparative process. If tension occurs during the progress of the healing process, it should be relieved by division of the sutures and the employment of such other means as may be found necessary.

Perfect Drainage.—The free escape of all fluids from a wound is essential to prompt repair and to the good condi-

Fig. 27.

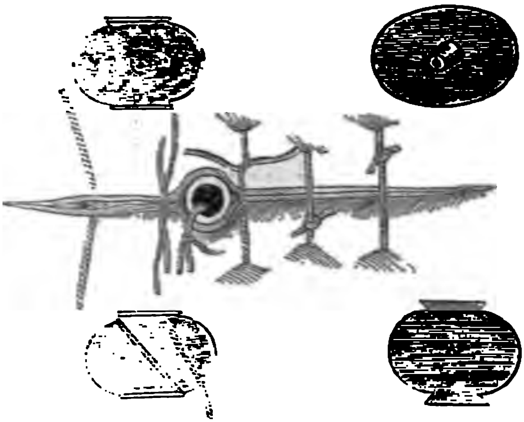
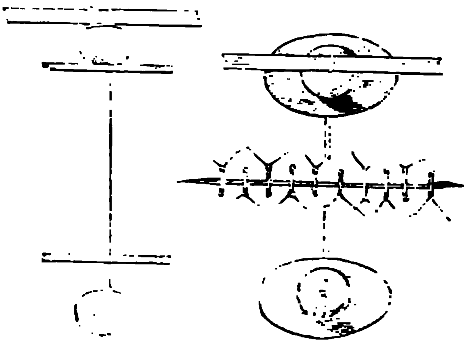


Fig. 28.



tion of the wound. This is accomplished by means of tubes or other means which conduct the fluids from the

wounds so that they be washed away or may be rendered innocuous by agents incorporated in the dressings. The proper introduction of drainage tubes is important in order that the deeper parts of the wound should be drained and accumulations of fluids prevented. It can be understood readily in what manner the collection of fluids between wound surfaces interferes with repair. The fluids may act either mechanically by separating the surfaces or chemically by the septic influences exerted by them.

Cleanliness.—In its fullest extent this term, as it relates to wound-treatment, includes cleanliness *in the wound*, or the parts *about the wound, of all substances and instruments coming in contact with it* and of *the hands* of those who, in any way, have anything to do with it. In wounds in which the surfaces are brought into contact, as after amputations, excisions of tumors, etc., it is essential that the surfaces should be thoroughly cleansed before approximation, so as to remove all blood-clots or shreds of tissue. In wounds which are treated aseptically the blood clots which may remain disappear by a process called organization, young cells developing in them, and new tissue being thus formed, the blood clots affording the pabulum for the cells. The cleansing of wound surfaces which are in contact may be effected by injecting tepid water or warm antiseptic solutions through the drainage tubes which have been introduced. This should be done at the time of the first dressing, and also at the redressings. Open wounds may be washed by injections with the syringe; for this purpose the fountain syringe is preferable, as a larger column of water can be obtained from it, and also the fluid is thrown with less force from it upon the surfaces. In the absence of a fountain syringe, the nasal douche bottle can be used. A gallon tin measure can be

6

readily adapted by the tinsmith to the purpose of a wound douche.

Cleanliness about the wound is effected by scrubbing the parts with soapsuds for some distance in all directions about the intended site of an operation, and afterward washing with an antiseptic lotion. In the redressings these surfaces are kept clean by washing carefully with the antiseptic solution, usually carbolic acid solution one-in-twenty.

Cleanliness with regard to the dressings, sponges, and instruments is of paramount importance in preventing the entrance into the wound of septic agents. The general introduction of antiseptic methods permits of the employment of chemically clean dressings at slight cost and of processes by which sponges and instruments may be kept clean. With our present knowledge of wound-treatment no surgeon can be excused for want of care in this respect. Cleanliness of the hands of the surgeon and assistants is important, and thorough washing should be practised before operations or redressings. Especial attention should be given to the folds of the skin about the finger nails and to the removal of dirt beneath the nails. The one-to-forty solution of carbolid acid is of sufficient strength to render the surfaces free from septic matter.

Rest.—Perfect rest of a wounded part is essential to its prompt repair. This may be accomplished by means of [illegible] and the use of [illegible]ges and *splints*.

Position.—In all cases that position should be selected which affords the most comfort to the patient and promotes the free escape of fluids from the wound. In injuries of the lower extremity it is desirable to elevate the limb either in a fixed apparatus or in a swing. When the limb is swung the parts are not disturbed by movements of the patient.

and in this way great comfort is obtained as well as freedom from pain. In the treatment of wounds of both extremities elevation of the limb should be secured so as to maintain the free circulation of the blood through the part.

Bandages.—By means of bandages equable compression may be made which will control muscular spasm and afford support to the bloodvessels. They should be applied from the distal extremity, and should be carried over the wound to some distance above it. Great care should be exercised in order to avoid making undue pressure. Sufficient traction should be made to give comfortable support to the parts if it is carried beyond that point harm may be done.

Splints.—The use of splints is important in obtaining rest of a wounded part. Immobilization of the entire limb may be obtained by the employment of the plaster dressings. In the treatment of injuries of the joints fixation of the limb is very desirable. In applying splints care should be taken to protect the surfaces by covering them with cotton-wool or some soft material which will adapt itself to the inequalities of the part. Splints should be made of light material which can be moulded to the part.

In the treatment of wounds the surgeon should always bear in mind the great importance of maintaining the patient in the most favorable hygienic conditions possible to be attained, and of giving attention to the state of the general system. The relation which the condition of a wound may have to the constitutional state of the patient should not be overlooked, otherwise the healing process may be seriously interfered with, despite the most perfect dressings. As perfect ventilation as is possible of the apartment in which the patient is placed should be secured, in order not only that a full supply of fresh air should be admitted, but also that

the air which is charged with the exhalations f
and with other contaminations should escape.

While it is hoped that pus will not form un
septic method of dressings, yet it is not claime
not occur. In such cases the "antiseptic sup
it is called, is said to be "due to the direct chem
of the antiseptic."

[redacted]

PART II.

BANDAGING.

BANDAGING is the art of applying bandages. Bandages are substances which are employed in the treatment of surgical affections, and consist of the *simple* and the *compound*. They may be made from various materials, such as muslin, flannel, etc. For general use the material best adapted is unbleached muslin; that which is firm, smooth, soft, and closely woven should be selected.

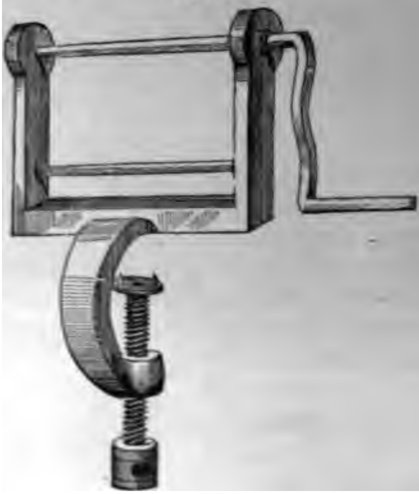
THE SIMPLE BANDAGE OR ROLLER.

This may be from one to four inches in width, and from six to twelve yards in length. The ordinary roller used in practice is six to eight yards long, and two to two and a half inches wide. In preparing the roller a piece of muslin, six to twelve yards in length and one yard in width, should be soaked in water for some time in order to cause shrinkage, then dried, and smoothly ironed. The selvage is removed, the free edge divided by the scissors at the points marking the widths of the bandages, and the strips torn rapidly, so as to avoid too much unravelling.

In order to apply the bandage it should be formed into rollers or cylinders; this can be done by a machine (Fig. 24) or by the hand. It is quite desirable that the student

should learn to roll the bandage firmly by the hand, as the machine is not always convenient, and, besides, constant

Fig. 29.



handling of the bandage gives him better knowledge and control of it. The strips can be conveniently made into rollers in the following manner: Having arranged a strip in regular folds, a graduated compress is formed at one extremity and turned over firmly upon the thigh and rolled a few times until a cylinder is formed of such size as to be readily grasped by the hand; then it is placed between the thumb and index and middle fingers of the left hand, the body of the bandage being held by the thumb and extended index finger of the right hand, while the remaining fingers grasp the cylinder. The cylinder thus held is made to revolve upon its axis by the left hand, while the right revolves par-

[redacted]

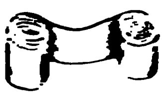
tially around the roller itself, these movements soon completing its formation. In forming the roller in this manner, the cylinder may be held in either the right or left hand, as is most convenient (Fig. 30). The roller should be firmly and compactly formed, so that the central portion or axis cannot be pushed out readily. Practice will enable the student to accomplish the formation rapidly and firmly. After forming the roller it should be firmly grasped and all loose threads removed, as these interfere with its proper application.

Fig. 30.

Rollers are of two kinds, *Single-headed* and *Double-headed*. The single-headed roller consists of a body or central part, an initial and a terminal end, and an external and internal surface (Fig. 31). The double-headed roller has the same parts as the single-headed, both ends being formed into rollers (Fig. 32). The dimensions of the roller for the different parts of the body vary.

Fig. 31.

Fig. 32.



For the Head—Five yards long and two inches wide.

For the Body—Twelve yards long and four inches wide.

For the Extremities—Eight yards long and two to three inches wide.

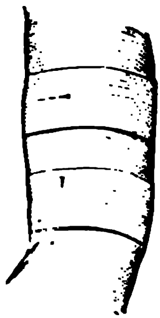
[redacted]

For the Hand—From five to eight yards long and one inch wide.

The application of the roller should begin by placing the external surface of the initial end in contact with the part, securing it in position by a circular turn, and the cylinder should be held firmly in the palm of the hand. When the application is completed, the terminal end should be fastened by folding in the edge and introducing a pin transversely or longitudinally as may be most convenient, the head being directed upward or outward (Figs. 33, 34), care being taken

Fig. 33.

Fig. 34.



[illegible] Pins should be introduced at the points where the turns of a roller cross one another, so as to hold them in place. In applying a bandage to an extremity, it should be begun at the distal part, in order to make equable pressure upon the blood vessels.

If a wet bandage is to be applied, it should be soaked in the bottom before application, otherwise, undue contraction will result if made wet when it is on the limb.

The amount of traction to be used in the application of a bandage is a matter of the utmost importance, and should

be very carefully considered by the student; practice alone will enable him to acquire a proper knowledge upon this point. A bandage too tightly applied may do great harm, even to the production of gangrene (Fig. 35), the loss of a limb, and possibly the loss of life. The sensations of the patient and the condition of the circulation in the limb, as shown at the distal points, are the best guides. These should be carefully noted a short time after the application of the bandage. If the patient complains of pain and numbness in the limb, and if the temperature of the part is lowered and the skin gives evidence of retarded circulation, then the bandage should be immediately removed. With regard to the tension the patient should always be consulted, and inspections at short intervals should be made.

Fig. 35.

Gangrene from tight bandaging.

In applying the bandage

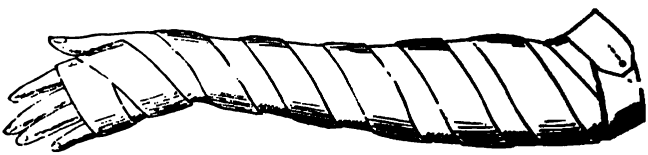
to the head or trunk, the student should stand at the *side* of the patient, not in front of or behind, and in making the various turns of the roller he should not *walk around* the patient but maintain a *fixed position*. In conveying the turns about the part, the bandage should be unrolled with an even and steady movement, not by short jerks. In removing the bandage from a part, each turn should be carefully taken off and folded in the band.

Bandages are designated as the CIRCULAR, OBLIQUE, SPIRAL, SPIRAL-REVERSE, FIGURE-OF-8, SPICA, and RECURRENT, according to the direction they take in application.

The *Circular* bandage consists of circular turns about the part.

The *Oblique* bandage covers the part by very oblique turns (Fig. 36).

Fig. 36.



The *Spiral* bandage is applied by making spiral turns, each succeeding turn covering one-half of the preceding (Fig. 37). The reverse turn in this bandage is made in order that the bandage may adapt itself equably and with more firmness to the part. In making it, the limb should be grasped by the left hand, so as to retain the preceding turn by the thumb and fingers; the roller, with not more

than three inches unrolled, should be held above the part, the hand being in a state of supination. The unrolled por-

Fig. 37.

tion of the bandage being kept perfectly lax, the right hand, holding the roller, should be turned from supination into

Fig. 38.

pronation (Fig. 38), making in this movement a *short* turn, and passing the roller under the limb into the left hand.

The position of the roller in the hand should not be changed, nor should traction be made until the limb is passed.

The reverse turns will be in a line, if care is taken to keep the spaces between the successive turns of the bandage equidistant: they should not be made over a joint or a subcutaneous bone, owing to the increased pressure they exert.

In the *Figure-of-8* bandage the turns cross each other so as to resemble the figure after which it is named.

The *Spica* bandage is so named from its resemblance to the arrangement of the leaves of an ear of corn.

The *Recurrent Bandage*.—In this the turns return successively to the point of origin, so as to form a covering for a part.

The simple bandage consists of the Roller, either single or double headed, and is applied to various parts of the body.

BANDAGES OF THE HEAD.

Length of roller five yards, width two inches.

1. Circular bandage of the forehead.
2. Circular bandage of the eyes.
3. Crossed bandage of one or both eyes.
4. Crossed bandage of the angle of the jaw.
5. Knotted bandage of the head.
6. Recurrent bandage of the head, with single or double-headed roller.
7. Gibson's bandage for the body of the lower jaw.
8. Rhea Barton's bandage for the body of the lower jaw.

1. Circular Bandage of the Forehead.

Origin—Side of the head.

Course—Three or four turns encircling the vault of the cranium.

[redacted]

Termination—Side of the head opposite to the point of origin.

Use—To make pressure or retain dressings to the head.

2. Circular Bandage of the Eyes.

Origin—Temporal region.

Course—Three or four turns over the eyes and around the head.

Termination—Temporal region, opposite to the point of origin.

Use—To retain dressings to the eyes.

3. Crossed Bandage of the Eyes.

Origin—Side of the head.

Fig. 39.

Fig. 40.

Course—Two circular turns around the head in a direction from right to left to cover the right eye, from left to

right to cover the left eye, thence to the nape of the neck, applying the bandage to the surface by a reverse turn, if necessary, under the ear, over the eye, across the root of the nose to the side of the head, on a level with the parietal eminence, then circular turn around the head, making two or three turns in this manner alternately, and covering two-thirds of each preceding turn.

Termination—Circular turn around the head.

Use—To retain dressings to the eye (Fig. 39).

To cover both eyes, after the first turn over the eye has been made, the bandage should pass around the head and then down across the forehead, the root of the nose, over the other eye, under the ear, to the occiput and side of the head, thence around the head to the nape of the neck, and pass in the same direction as in the first turn. Applying these turns alternately, both eyes will be covered.

Use—To retain dressings to both eyes (Fig. 40).

4. Crossed Bandage of the Angle of the Jaw.

Roller and compress.

Initial—Side of the head.

Course—Two circular turns around the head, in a direction from right to left to cover *left* angle, and left to right to cover *right* angle, to the nape of the neck, making a reverse turn, if necessary, behind the ear, under the jaw, over the angle of the jaw, up in front of the ear, over the vertex obliquely, down behind the ear of the side opposite, under the jaw and repeat the turns, advancing from the angle of the jaw to the corner of the mouth.

Termination—By a reverse turn on the side of the head opposite to the injured side, and making two circular turns from before backward around the head.

[redacted]

Fig. 41.

Use—To support parts in the treatment of fracture of the angle of the jaw (Fig. 41).

5. Knotted Bandage of the Head. Double-headed roller and compress.

Origin—Body of the bandage over the compress covering the wound in the artery.

Course—Carry both heads of the roller around the head in opposite directions, passing at the temporal region of the opposite side and returning to point of origin. Change the direction by making a half turn or twist over the compress, carrying the heads of the roller in opposite directions over the vertex and under the chin to the temple of the opposite side, passing and returning to point of origin, where a second turn or twist should be made and the heads of the roller con-

duced as in first turn, placing the knots behind each other in order. Continue these turns until three or four knots are formed.

Termination.—Circular turns around the head, covering the knots.

Use.—To make compression in wound of the temporal artery (Fig. 42).

NOTE.—This bandage, being applied with great firmness, makes great pressure upon the parts, and should be watched carefully in order to prevent injury.

Fig. 42.

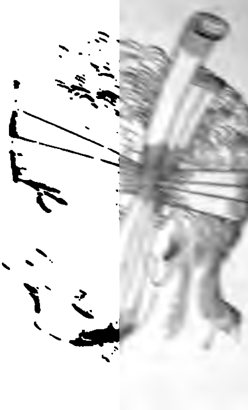


Fig. 43.

6. Recurrent Bandage of the Head. Single-headed roller.

Origin.—Side of the head.

Course.—Two circular turns around the head to the middle of the forehead, then reversing the bandage and carrying it from before backward to the middle of the occiput, making

[redacted]

a reverse turn and returning to the forehead, covering one-half of the preceding turn and continuing recurrent turns on alternate sides, covering one-half of each preceding turn, until the vertex is covered.

Termination.—By a reverse turn and then circular turns around the head to secure recurrent turns (Fig. [illegible]).

Recurrent Bandage of the Head. Double-headed roller.

Origin.—Body of the bandage over the middle of the forehead.

Course.—The heads of the roller are to be carried in opposite directions around the vertex to the occiput, passing and

Fig. [illegible].

returning to the point of origin; the recurrent turns are to be made by the head of the roller held in the right hand

[illegible] being secured by circular turns made by the head [illegible] in the left hand (Fig. 44): continue these [illegible] the vertex is covered.

[illegible] circular turn around the head.

[illegible] bandages are used to retain dressings to the [illegible]

[illegible] Gibson's Bandage for the Body of the Lower Jaw.

[illegible]

[illegible] the ear, under the chin, up in [illegible] side, over the middle of the ver- [illegible] making two turns: then reverse [illegible] making two circular [illegible] point of origin: thence to the [illegible] turn if necessary, carrying [illegible] and back to nape of the [illegible] turn and go to side [illegible] turns to the middle [illegible] carry bandage over [illegible]

[illegible] turns around the head [illegible]

[illegible] turn of the body [illegible]

[illegible] Barton's Bandage

[illegible]

[illegible] eminence, [illegible] down [illegible] the ear of [illegible] sagittal and

coronal sutures, over the parietal eminence to the point of origin; thence obliquely downward and forward over the

Fig. 45.

Fig. 46.

angle of the jaw, in front of the chin, over the angle of the jaw of the opposite side, obliquely upward and backward to the point of origin. Continue these turns until the bandage is exhausted (Fig. 46).

Termination—Occipital region, or by a turn around the head.

Use—To support the parts in treatment of fracture of the body of the lower jaw.

BANDAGES OF THE TRUNK.

1. Circular bandage of the neck.
2. Figure-of-8 bandage of the neck and axilla.
3. Anterior figure-of-8 bandage of the chest.
4. Posterior figure-of-8 bandage of the chest.
5. Crossed bandage of one or both breasts.

Bandage of the **Neck**. Length of

the neck.

Bandage of the **Neck and Ax-**

Bandage of the **Chest**.

upward, across the chest to the opposite shoulder, over the shoulder, backward and downward to the border of the axilla,

Fig. 47.

under the axilla, repeating these turns three or four times (Fig. 48).

Termination—By circular turns around the chest.

Use—To draw the shoulder forward, and to retain dressings on the anterior surface of the chest.

Fig. [illegible]

[illegible] Bandage of the Chest.

[illegible] that just de-

[illegible]

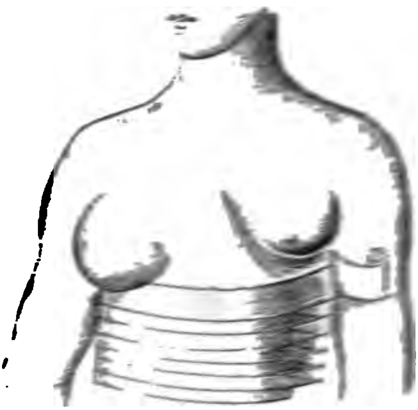
Use.—To draw the shoulders back in the treatment of fracture of the clavicle, or to retain dressings on the posterior surface of the chest.

5. Crossed Bandage of one or both Breasts. Length of roller, eight yards; width, two and one-half inches.

Origin.—Axilla of the affected side.

Course.—Two circular turns under the breasts, around the chest to the point of origin, thence obliquely upward under the affected breast, across the front of the chest to the shoulder, over the shoulder, obliquely downward across the back

Fig. [illegible]



to the point of origin, then by a circular turn under the breasts, around the chest to the point of origin; continue these turns alternately, gradually ascending toward

Fig. 48.

4. Posterior Figure-of-8 Bandage of the Chest.

This bandage is applied in the same manner as that just de-

Fig. 49.

scribed, the turns being carried over the posterior instead of the anterior surface of the chest (Fig. 49).

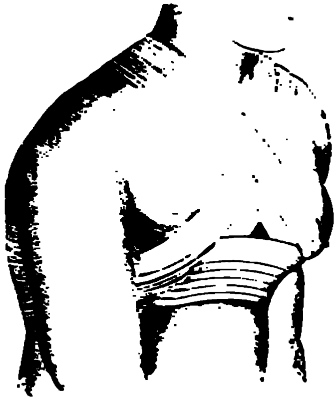
in the oblique turns, and upward in the circular turns until the breast is fully supported (Fig. 50).

Termination.—Circular turns around the chest.

Bandage for both Breasts. Length of roller, twelve yards; width, two and one-half inches.

This bandage is applied in the same manner as that just described, with the addition of oblique turns, supporting the other breast, which begin when the bandage, in the second circular turn, the first oblique turn having been made, has reached the opposite axilla; then pass across the back of the chest, over the shoulder, down obliquely across the front of

Fig. 51.



the chest under the breast to the point of origin. These turns are continued, the circular and oblique turns alternating, until both breasts are supported (Fig. 51).

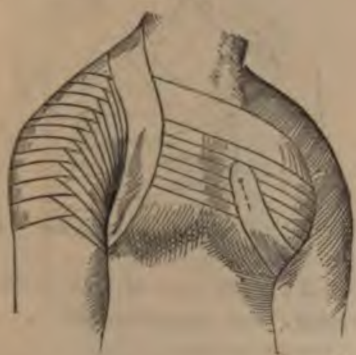
Use.—These bandages are used to support the breasts in excessive lactation, or in abscess.

6. Spica Bandage of the Shoulder. Length of roller, eight yards; width, two and one-half inches.

Origin—Arm of the injured side.

Course—Circular and spiral reverse turns to the point of the shoulder, over the shoulder, obliquely downward across the front of the chest, for the right shoulder, and the back of the chest for the left shoulder, to the axilla of the sound side, under the axilla, obliquely upward across the front or back of the chest to the point of the shoulder, down in front or behind to the border of the axilla, under the axilla to the point of the shoulder, covering one-half of the preceding turn, thence to the axilla of the sound side. Continue these turns, covering one-half of each preceding turn, until the shoulder is covered (Fig. 52).

Fig. 52.



Termination—Circular turns around the chest.

Use—To retain the head of the humerus in place after dislocation has been reduced.

8

7. Spiral Bandage of the Chest. Length of the roller, ten yards; width, three to four inches.

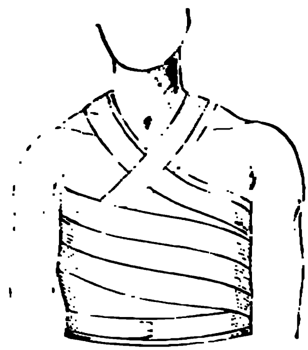
Origin—Circular turns around the waist.

Course—By spiral turns around the chest, ascending to the axilla, covering one-half of each preceding turn.

Termination—Circular turns around the upper part of the chest.

Use—To make compression in fracture of the sternum or ribs, and to retain dressings (Fig. 53).

Fig. 53.



8. Circular Bandage of the Abdomen. Length of the bandage, from one-and-a-half to two yards; width, from ten to twelve inches.

Origin—Over the crest of the ilium.

Course—Circular turn around the abdomen.

Termination—Over the crest of the ilium.

Use—To support the abdominal walls.

9. Spiral Bandage of the Abdomen. Length of the roller, ten to twelve yards; width, three to four inches.

Origin—Around the waist, or over the crest of the ilium.

Course—Spiral turns from above downward, or from below upward.

Termination—By circular turns around the pelvis or around the waist, according to the course taken.

Use—To make compression of the abdomen or to retain dressings.

10. Spica Bandage of one or both Groins. Length of roller, eight to ten yards; width, two-and-a-half to three inches.

Fig. 54.

Origin—Above the crest of the right ilium.

Course—Two circular turns around the body above the

crest of the ilium, thence obliquely downward across to the inside of the right thigh to cover the right the outside of the left thigh to cover the left groin the thigh, across the groin obliquely upward to al crest of the left ilium, and then to point of origin these turns, and cover one-half of each preceding turn the groin is covered (Fig. 54).

Fenestration—Circular turns above the crest of the

Fig. 55.

—To make compression over the groin, as in case of or to retain dressings. To cover both groins, the turns, as described above, should be made to alternate (Fig. 55).

11. The Spiral. Reverse of the Penis. Length of roller, eighteen to twenty-four inches; width, one inch.

Origin—Behind the glans penis.

Course—Spiral and spiral reverse turns to the root of the penis.

Termination—Root of the penis, fastened by slitting the terminal extremity and tying the two ends.

Use—To retain dressings to the penis.

Fig. 56.

BANDAGES OF THE EXTREMITIES.

SUPERIOR EXTREMITY.

Bandages of the Hand.

1. Spiral bandage of the finger.
2. Spiral bandage of all of the fingers, or the gauntlet.
3. Spiral bandage of the palm, or demi-gauntlet.
4. Spica bandage of the thumb.

1. Spiral Bandage of the Finger. Length of roller, one yard; width, one inch.

Origin—Circular turns around the wrist.

Course—From the wrist across the back of the hand to the base of the finger, thence by very oblique turns to the point of the finger, returning to the base by spiral or spiral-reverse turns, and thence to wrist (Fig. 57).

Termination—Circular turns around the wrist.

Use—To retain dressings or to support parts in fracture.

... Bandage of all of the Fingers, or the ... one inch.

... same direction as those in ... separately.

... wrist

3. Spiral Bandage of the Palm, or Demi-Gauntlet. Length of roller, six yards; width, one inch.

Origin—Around the wrist.

Course—By circular turns around the wrist, thence downward across the back of the hand to the first interdigital space around the base of the finger, across the back of the hand to the wrist. Repeat these turns around the base of each finger until the back of the hand is covered.

Termination—Circular turns around the wrist.

Use—To retain dressings on the back of the hand.

4. Spica Bandage of the Thumb. Length of roller, three yards; width, one inch.

Origin—Around the wrist.

Course—From the wrist across the base of the thumb to the phalangeal articulation, around the thumb, across the

Fig. 59.

base of the thumb to the wrist, and continue these turns, covering one-half of each preceding turn, until the thumb is covered (Fig. 59).

Termination—Around the wrist.

Use—To make pressure over the base of the thumb, or to confine dressings.

[redacted]

the arm and returning obliquely downward across the front of the elbow to upper part of the forearm; then by ascending spiral turns covering the entire joint.

Termination—Circular turn around the arm.

Use—To make pressure over the elbow-joint, or to retain dressings.

4. Circular Bandage of the Forearm or Arm. The application of this bandage consists in making circular turns around any part of the forearm or arm.

Use—To retain dressings or to compress the superficial veins in venesection.

5. Oblique Bandage of the Forearm or Arm. Length of roller, two to three yards: width, two inches.

Origin—Around the hand.

Course—Two circular turns around the hand, thence by very oblique turns up the forearm and arm to the shoulder.

Termination—Circular turns around the upper part of the arm.

Use—To retain dressings.

6. Spiral Bandage of the Arm. Length of roller, three to five yards; width, two inches.

Origin—Figure-of-8 turn of the wrist and hand.

Course—By spiral turns up the forearm and arm to the shoulder.

Termination—Circular turns around the upper part of the arm.

Use—To retain dressings.

7. Spiral-Reverse Bandage of the Upper Extremity. Length of roller, eight yards; width, two inches.

Fig. 60.

Origin.—Around the wrist by two circular turns.

Course.—From the wrist obliquely downward across the back of the hand to the metacarpo-phalangeal articulation, one or two circular turns around this articulation, thence obliquely upward across the back of the hand to the wrist, completing figure-of-8 turn of the wrist; then spiral turns over the wrist-joint, ascending the forearm by spiral-reverse turns to the elbow, crossing the elbow-joint by figure-of-8 turn and covering with spiral turns, and ascending the arm to the shoulder by spiral-reverse turns (Fig. 60).

Termination.—Circular turns around the upper part of the arm.

Use.—To support the arm in the treatment of fractures, dislocations, etc.

This bandage may begin by circular turns around the hand, over the metacarpo-phalangeal articulations, and then pass to the wrist by figure-of-8 turns. In passing over the wrist and elbow-joints, simple spiral turns should be made; reverse turns increase the pressure and may do harm.

[redacted]

BANDAGES OF THE INFERIOR EXTREMITY.

1. Figure-of-8 bandage of the ankle.
2. Figure-of-8 bandage of the knee.
3. Figure-of-8 bandage of the thighs.
4. Spica bandage of the instep.
5. Spiral-reverse bandage of the lower extremity covering the heel.
6. French spiral bandage.

1. Figure-of-8 Bandage of the Ankle. Length of roller, two yards; width, two inches.

Origin—Around the leg, above the malleoli.

Course—Two circular turns around the leg above the malleoli, thence obliquely downward in front of the ankle to the side of the foot, under the sole of the foot to the opposite side, obliquely upward in front of the ankle to the point of origin, making as many turns as may be required.

Termination—Circular turns above the malleoli.

Use—To cover in the ankle or to retain dressings.

2. Figure-of-8 Bandage of the Knee. Length of roller, two yards; width, two-and-one-half inches.

Origin—Side of the upper part of the leg.

Course—Two circular turns around the upper part of the leg, thence from side of the leg obliquely upward across the front or back of the knee to the side of the lower part of the thigh, circular turn around the thigh, then from opposite side of the thigh obliquely downward across the front or back of the knee to side of the leg, making the required number of figure-of-8 turns, and covering the joint by ascending spiral turns.

Termination—Circular turns above the knee.

Use—To cover in the knee or to make compression.

3. Figure-of-8 Bandage of the Thighs. Length of roller, five to six yards; width, two and one-half to three inches.

Origin.—Above the knees.

Course.—Beginning by circular turns above the knees, and making as many figure-of-8 turns as may be required to secure the limbs firmly together.

Termination.—Circular turns around the upper part of the thighs.

Use.—To fasten the thighs together after operations or injuries.

4. Spica Bandage of the Instep. Length of roller, six to eight yards; width, two inches.

Origin.—Around the metatarso-phalangeal articulation.

Course.—By two circular turns around the foot, ascending by spiral-reverse turns to the instep, then obliquely downward to the point of the heel, the edge of the bandage projecting slightly below the border of the sole of the heel, around the heel, obliquely upward to the instep, downward to the side of the foot, under the foot to the opposite side of the foot and to the instep; continue these figure-of-8 turns, covering one-half of each preceding turn until the instep is entirely covered (Fig. 61).

Fig. 61.

Termination.—Circular turn above the ankle.

Use.—To make firm compression over the instep or ankle.

5. Spiral-reverse Bandage of the Lower Extremity covering the Heel. Length of roller, ten to twelve yards; width, two-and-one-half inches.

Fig. 62.

Origin—Around the foot at the metatarso-phalangeal articulation.

Course—Two circular turns around the foot, ascending by spiral-reverse turns to high up on the instep, thence over the point of the heel, back to the instep, under the sole of the heel, over the side of the heel, around the back of the heel, up to the instep, under the sole of the heel, over the opposite side of the heel, around the back of the heel up to the instep, then figure-of-8 turns of the ankle, spiral turns over the joint, spiral-reverse turns to the knee, figure-of-8 turn of the knee, spiral turns over the joint, and ascending the thigh to the hip by spiral-reverse turns (Fig. 62).

Termination—Circular turns around the upper part of the thigh.

Use—To support the limb after fracture, etc.

This bandage may begin around the ankle and pass to the foot, covering it, and return by figure-of-8 turns to the ankle, and then ascend the limb. Reverse

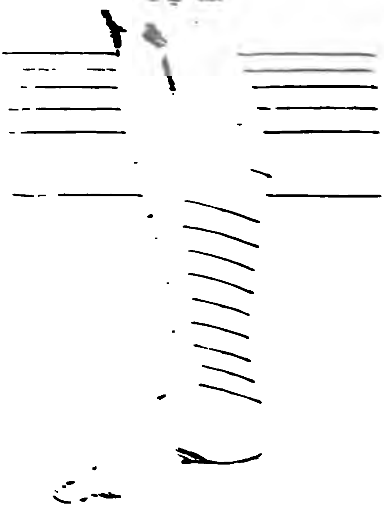
turns should not be made over the ankle or knee-joints, or over the crest of the tibia, owing to the increased pressure they exert.

4. **French Spiral Bandage.** This bandage is applied in the same manner as the preceding, the covering of the heel being omitted, passing from the foot to the leg by figure-of-8 turns.

GENERAL BANDAGES.

Bandage of Scultetus. This bandage consists of a number of separate pieces varying in length, the first being sufficiently long to go once and a third around the upper part of the limb, each succeeding piece decreasing one inch. The pieces should be arranged so that each strip covers in one-third of that preceding. The limb is placed upon the strips arranged in order, and the application is commenced at the lowest part, crossing one strip over the other in an oblique direction (Fig. 63).

Fig. 63.



Use—To support the limb in cases of com-

pound fractures, etc., where it is advisable to avoid motion in removing dressings.

Recurrent Bandage for Amputations. Length of roller, four to six yards; width, two to two-and-one-half inches.

Origin—Three to six inches above the end of the stump.

Course—Two circular turns around the limb to the centre of the under surface, thence by recurrent turns over the extremity of the stump to the centre of the upper surface; continue these recurrent turns on alternate sides of the central turn, covering in one-half of each preceding turn, until the stump is covered. Fix the recurrent turns by spiral or spiral-reverse turns descending to the end of the stump (Figs. 64, 65).

Fig. 64.

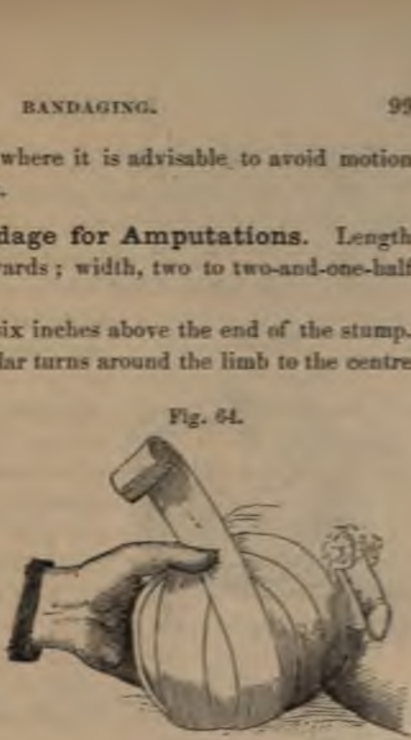


Fig. 65.

Termination—Circular turn around the stump.

Use—To support the flaps of the stump after amputation.

Velpeau's Bandage. Position of the arm: hand of the injured side grasping the sound shoulder. Length of roller, ten to twelve yards; width, two-and-one-half inches.

Origin.—The axilla of the sound side.

Course.—Obliquely upward across the back of the chest, to the seat of the fracture, over the compress, covering the seat of the fracture, down across the outside of the arm to under the elbow, in front of the chest to the axilla of the sound side, thence by a circular turn across the back over the outside of the point of the elbow to the axilla of the sound side. Continue the oblique and circular turns alternately, advancing over the arm and ascending from the point of the elbow until the arm is firmly supported

Fig. [illegible]

Termination.—By circular turn around the chest.

Use.—To support the arm in the treatment of fracture of the clavicle and the acromion process of the scapula.

In applying this bandage, a compress of soft material should be placed between the arm and the surface of the chest to prevent excoriation.

Desault's Apparatus. This consists of three single-headed rollers, a triangular pad to place in the axilla, and a sling to support the hand.

The pad should be of such length as to extend from the axilla to the point of the elbow, and measure in width at

the base from three to four inches. Length of rollers, eight yards; width, two and one-half inches.

FIRST ROLLER. *Origin*—Over the apex of the pad; placed in the axilla of the injured side.

Course—Two circular turns around the chest over the apex of the pad, thence by spiral turns upward to the axilla, covering the pad and securing it in place.

Termination—By circular turns around the chest.

This roller can be dispensed with to advantage, and the pad held in place by tapes attached to its base passing around the neck. The arm should now be flexed at a right angle, pressing slightly against the side of the chest.

SECOND ROLLER. *Origin*—Axilla of the sound side.

Course—Circular turn across the front of the chest, over the upper part of the arm of the injured side, across the back of the chest to the point of origin, then by spiral turns *descending* to below the point of the elbow.

Termination—Circular turns around the body.

Use—To throw the shoulder outward by pressing the elbow inward, using the pad as a fulcrum.

Fig. 67.

THIRD ROLLER. *Origin*—Axilla of the sound side.

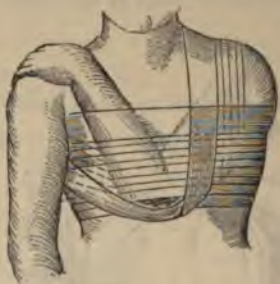
Course—Obliquely upward across the front of the chest to the seat of the fracture, over the seat of the fracture, down back of the arm to the elbow, under the elbow, across in front of the chest to the

Velpeau's Bandage. Position of the arm; hand of the injured side grasping the sound shoulder. Length of roller, ten to twelve yards; width, two-and-one-half inches.

Origin—The axilla of the sound side.

Course—Obliquely upward across the back of the chest, to the seat of the fracture, over the compress, covering the seat of the fracture, down across the outside of the arm to *under* the elbow, in front of the chest to the axilla of the sound side, thence by a circular turn across the back *over* the outside of the point of the elbow to the axilla of the sound side. Continue the oblique and circular turns alternately, advancing over the arm and ascending from the point of the elbow until the arm is firmly supported (Fig. 66).

Fig. 66.



Termination—By circular turn around the chest.

Use—To support the arm in the treatment of fracture of the clavicle, the neck, or acromion process of the scapula.

In applying this bandage, a compress of soft material should be placed between the arm and the surface of the chest to prevent excoriation.

Desault's Apparatus. This consists of three single-headed rollers, a triangular pad to place in the axilla, and a sling to support the hand.

The pad should be of such length as to extend from the axilla to the point of the elbow, and measure in width at

the base from three to four inches. Length of rollers, eight yards; width, two and one-half inches.

FIRST ROLLER. *Origin*—Over the apex of the pad; placed in the axilla of the injured side.

Course—Two circular turns around the chest over the apex of the pad, thence by spiral turns upward to the axilla, covering the pad and securing it in place.

Termination—By circular turns around the chest.

This roller can be dispensed with to advantage, and the pad held in place by tapes attached to its base passing around the neck. The arm should now be flexed at a right angle, pressing slightly against the side of the chest.

SECOND ROLLER. *Origin*—Axilla of the sound side.

Course—Circular turn across the front of the chest, over the upper part of the arm of the injured side, across the back of the chest to the point of origin, then by spiral turns *descending* to below the point of the elbow.

Termination—Circular turns around the body.

Use—To throw the shoulder outward by pressing the elbow inward, using the pad as a fulcrum.

Fig. 67.

THIRD ROLLER. *Origin*—Axilla of the sound side.

Course—Obliquely upward across the front of the chest to the seat of the fracture, over the seat of the fracture, down back of the arm to the elbow, under the elbow, across in front of the chest to the

point of origin; thence obliquely upward across the back of the chest to the seat of the fracture, over the seat of the fracture, down in front of the arm, under the elbow, across the back of the chest to the point of origin (Fig. 67).

[illegible]—Circular turns around the chest.

Use—To carry the arm upward and backward.

It will be observed that two triangles are formed in applying the third roller, the first having the base *behind* the arm, the sides across the front of the chest, and the apex in the axilla of the sound side; while the second has the base in front of the arm, the sides across the *back* of the chest, and the apex in the axilla of the sound side.

Use of the Apparatus.—To support the arm and overcome its displacement in the treatment of fractures of the clavicle.

THE COMPOUND BANDAGES.

Under this name are included—

1. The T bandages.
2. The [illegible] bandages.
3. The [illegible] bandages.
4. The suspensory bandages.

1. The T Bandages. These derive their name from their resemblance to the letter T, and consist of a horizontal portion sufficiently long to surround the part to be covered, and a vertical piece half the length of the horizontal, firmly attached to its middle (Fig. 68). The bandage thus formed can be applied to various parts of the body. It is most frequently employed in retaining dressings to the perineum, when the horizontal portion is fastened around the body and the vertical band passed between the thighs and then attached

Fig. 68.

to the horizontal piece. The napkin worn by women during menstruation is a familiar example of this form of bandage.

2. The Invaginated Bandage. This bandage is formed by making strips or tails at the free extremity and at the proper distance cutting slits in the body of the bandage through which these tails pass. It was formerly used for the purpose of approximating the edges of wounds, but is now largely, if not altogether, discarded.

Fig. 69.

Fig. 70.

3. **The Sling Bandages.** These are made of pieces of muslin or other material of various lengths and widths, torn at each extremity into two or more tails, leaving a central portion or body (Fig. 69). They are quite useful in retaining dressings or supporting parts. In applying them, the central portion or body is placed upon the part, and the tails are carried in different directions about the part, and secured by pins or knots. The Four-Tailed or [illegible] Bandage is used in the treatment of fracture of the body of the lower jaw (Fig. 70).

4. **The Suspensory Bandages.** These are made in the shape of bags or sacs of various sizes, and are used for the purpose of retaining dressings or supporting parts. They may be made of such material as is deemed most suitable.

MAYOR'S SYSTEM OF HANDKERCHIEF DRESSINGS.

This system of provisional dressings was introduced by M. Mayor, of [illegible], in [illegible]. It consists in the use of the ordinary handkerchief, folded into various shapes, so as to accomplish the purposes of the [illegible]. The dimensions of the handkerchief vary according to the part to which it is applied, and may be made of any material which happens to be at hand. The forms into which the handkerchief may be made are: The Square, The Triangle, The Cravat, and The Cord.

The Oblong Square is made by folding the handkerchief once on itself.

The Triangle is made by folding the square so that the angles which are opposite come in contact.

The Cravat is made by folding the handkerchief in the form of the ordinary cravat.

The Cord is formed by twisting the cravat on itself.

The handkerchief in the form of the Square may be employed to retain dressings over the head.

In the form of the Triangle it can be used for the purpose of retaining dressings over the head (Fig. 71), the trunk, the shoulder, the elbow, the hand, the hip, the knee, and the foot; also to support or retain dressings over the mammary gland (Fig. 72), to act as a sling for the arm (Fig.

Fig. 71.

Fig. 72.

73), or to cover the stump after amputation (Fig. 74). In applying the handkerchief in the form of the Triangle, the

passed through the openings made in the end of the box, and then fastened by a knot.

The Cord is used where it is necessary to make firm pres-

Fig. 76.

Fig. 77.

age, as when it is applied over a compress in cases of hemorrhage. It may also be used in the form of the clove hitch for the purpose of making traction. The clove hitch is made by holding one end of the cord with the left hand and turning from the body a simple loop with the right (Fig. 70), placing this between the thumb and finger of the left hand, a second loop is made from the remaining portion of the body of the cord and held by the thumb and finger of the right hand; passing the second loop beneath the first, the hitch is formed (Fig. 71).

IMMOVABLE BANDAGES.

The Starch Bandage, the Plaster of Paris Bandage, and the Silica Bandage.

1. **The Starch Bandage.** In this form of bandage, the starch should be prepared so as to be of the same consistency as that used in the laundry. Before applying the bandage, compresses made of some soft material, folded so as to be [illegible] inch in thickness and of the same length as the limb, should be applied along each side, extending from the point at which the application of the bandage begins to the point at which it terminates. Holding these compresses in position, the first roller is applied to the limb. This roller is now thoroughly coated with the starch by means of a medium-sized paint brush, the interstices and spaces being well filled. Over this a second roller is applied and coated with the starch in the same manner. In this way a sufficient number of rollers should be applied until the parts are properly supported. If necessary, strips of pasteboard which have been soaked in the starch may be

placed on the sides of the limb, after the second bandage has been applied, about those points requiring most support.

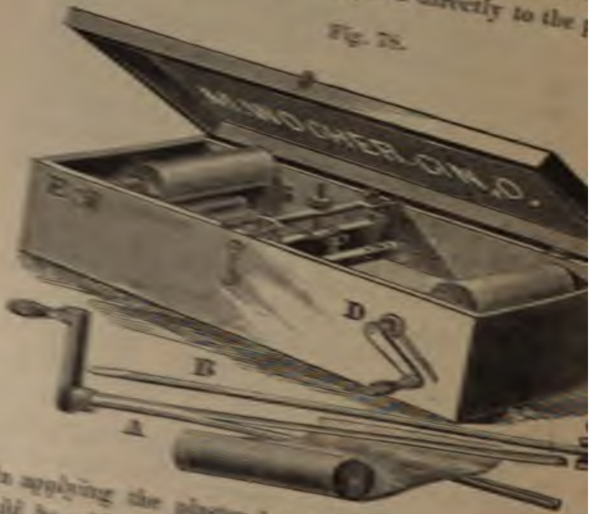
The compresses, which are placed on the sides of the limb, serve the purpose of protecting it from undue pressure caused by the drying of the starched bandages. They may be applied dry, or they may be soaked in the starch and then applied. In the leg they are especially serviceable in preventing pressure over the crest of the tibia, the two borders of the compresses, which are separated to a slight extent, supporting the bandage and keeping it from too close contact with the limb.

2. The Plaster of Paris Bandage. This bandage may be applied with rollers made of some loosely woven material, such as crinoline, Swiss muslin, cheese cloth, mosquito-netting, or with the ordinary muslin. When the first is used, it should be cut into strips, and dry plaster rubbed with the hand into its meshes on both sides, and then the strips should be formed into rollers and put in an air-tight tin vessel. Various forms of apparatus have been devised to accomplish the impregnation of the material with plaster. That of Dr. William Judkins, of Cincinnati, is shown in Fig. 78. When required, the rollers should be placed on *end* in a basin, containing water enough to cover them entirely, for one or two minutes, in order that they may become thoroughly wet, and in this condition they should be applied rapidly to the part; a free escape of bubbles of gas through the water takes place, and when this has ceased, the bandages are ready for application.

The roller, made of ordinary muslin, can be prepared by unrolling it in a basin containing water, thus becoming wet as it unrolls, and re-rolling it in a basin containing a

mixture of plaster and water of the consisten
In this way the surfaces become well coated wi
ter, and the roller can be applied directly to the

Fig. 78.



In applying the plaster bandage, the mixture of plast
should be rubbed over each roller with the hand after it i
applied. The setting of the plaster may be retarded by add-
ing a little size, a small quantity of borax, or stale beer.
If salt is added, its tendency to set will be increased. Gum-
water, white of egg, or flour-paste should be applied to the
surface after hardening has occurred, in order to prevent
chipping: a coat of varnish will render it impermeable to
moisture. In this form, the compresses should be placed
along the sides of the limb in the same manner as in the
starch bandage. In order to remove the plaster from the
hands after the application of the dressing the white of egg
may be used.

3. The Silica Bandage. In preparing this bandage a solution of the silicate of potassium or sodium is used. The roller is applied to the limb over the compresses, placed as above described, and it is thoroughly coated with the solution by means of a medium-sized painter's brush. As many rollers as may be deemed necessary are applied, each being thoroughly coated with the solution.

This is an excellent form of the immovable bandage, being easily applied, lighter than the plaster bandage, and hardening in a very short time.

4. The Dextrine Bandage. The solution of dextrine is prepared by mixing thoroughly ten parts of dextrine with six parts of brandy or camphor, and adding to it four parts of warm water. In these proportions the mixture assumes the consistence of molasses, and may be applied in the same manner as the starch.

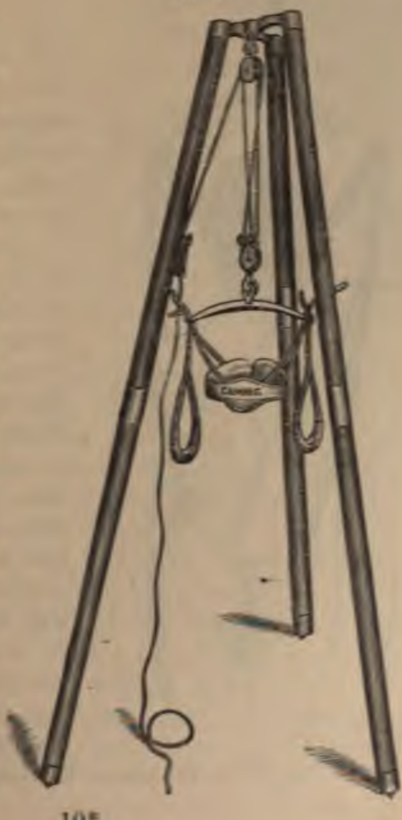
5. Tripolith. This substance has been recommended by Prof. von Langenbeck as possessing advantages over plaster of Paris. It consists of lime, silicon, and oxide of iron, and after application it is stated to be lighter and more durable than plaster of Paris. Dr. Nelson, of Boston, has made several trials of it, and pronounces it to be unsatisfactory as a dressing.

In addition to these forms of immovable bandages there are the Gum-and-Chalk, the Glue, the Glue-and-Oxide-of-Zinc, and the Paraffin bandages. These do not possess any advantages over those described above; the end to be accomplished—immobility of the parts—being secured by one as well as by the other.

Great caution should be observed in applying the rollers in these forms of bandage lest too much traction be em-

tiously divided. The starch bandage may be removed by one of these instruments. The plaster of Paris bandage in some instances may be unrolled from the part. The silica bandage may be readily removed after soaking it for a time in warm water.

Fig. 80.



Sayre's Suspension Apparatus for applying the Plaster Jacket. This is an apparatus devised by Prof. Lewis A. Sayre, of New York, for the purpose of suspending patients suffering from antero-posterior curvature of the spine during the application of the plaster of Paris bandage. The object to be accomplished by the suspension of the patient, is the separation of the diseased vertebræ, and the straightening, to a certain extent, of the column, the bandage being applied when the patient is suspended. When it

pad, composed of cotton loosely folded up in a handkerchief, is to be placed over the abdomen; it should be very thin at its lower part, so as not to make the jacket too loose. On the same principle, small pads are applied at either side of tender spots over prominent bony processes, and two folded cloths, three or four thicknesses each, just over the anterior iliac spines. The shirt being accurately applied, and kept smoothly stretched by means of the shoulder-tapes above and two tapes below, one in front and the other behind, tied over a handkerchief placed in the perineum, the patient is to be drawn up gently *until he feels comfortable* (Fig. 81).

A prepared and saturated roller, gently squeezed so as to get rid of all surplus water, is now applied around the smallest part of the body, and carried around the trunk downwards to a little below the crest of the ilium, then spirally from below upward until the entire trunk is encased from the pelvis to the axillæ. The bandage should be applied smoothly, and not drawn tight.

"After one or two thicknesses of bandage have been thus applied, several narrow strips of roughened tin are laid on either side of the spine, so as to surround the body, with intervals between them of two or three inches. Over these another plaster bandage is applied; very soon the plaster sets so firmly that the patient can be removed and laid upon his face or back upon a hair-mattress or air-bed. The pads are then removed, and the plaster gently pressed in with the hand in front of each iliac spine, so as to widen the case over the bony projections. While the patient is thus lying, it is sometimes necessary to wet the jacket with a little water, and then dust on some more plaster. As soon as the plaster has hardened, the patient may be allowed to walk about."

[redacted]

PART III.

FRACTURES.

DEFINITION.—A fracture of a bone is a solution of the continuity of its fibres.

VARIETIES.—Complete and Incomplete.

COMPLETE fractures embrace, Simple or Single—Comminuted or Multiple—Impacted—Compound—Complicated—Epiphyseal.

INCOMPLETE fractures include Fissures—Punctures—Partial fractures.

COMPLETE FRACTURES.—*Simple* or *Single.*—Those in which there is one point of fracture only, dividing the bone into *two* pieces or fragments (Fig. 82).

Comminuted or *Multiple Fractures.*—Those in which more than one point of fracture exists, the lines of separation communicating and dividing the bone into a number of pieces or fragments (Fig. 83).

Impacted Fractures.—In this form one fragment of the bone is driven forcibly into the other so as to become fastened firmly in its position (Fig. 84).

Compound Fractures.—In these there is a wound of the soft structures overlying the bone, so as to permit communication between the external surface of the part and the point of fracture. Where the fracture of the bone is com-

[redacted]

CAUSES OF FRACTURE.

Predisposing and Exciting.—The predisposing causes include *age*, *sex*, *occupation*, and *diathesis*.

Age.—As age advances the relation between the proportion of organic and inorganic elements in the bones changes, the inorganic or earthy predominating to such extent as to render the bones fragile and liable to fracture on the application of force.

Sex.—Males, by reason of their modes of life, are more exposed to the conditions which produce fractures than females.

Occupation.—Occupation contributes to the occurrence of fractures in a marked degree. The daily work of the mechanic and laborer exposes them to causes from which the merchant and professional man are exempt.

Diathesis.—Certain diseases, as cancer, syphilis, rachitis, and other constitutional affections, produce such morbid conditions in the osseous system as predispose to the occurrence of fracture.

The exciting causes of fracture are *mechanical or external violence* and *muscular action.*

Mechanical violence is the most frequent cause, and may be applied in two ways: *directly*, or by direct application of the force to the part, and *indirectly*, or by counter-stroke, where the force is transmitted from a point of contact more or less remote.

Muscular Action.—Certain bones of the skeleton, as the patella, os calcis, and the olecranon process of the ulna, receive the attachments of powerful muscles, which, when called into extraordinary action, may exert such force upon the bones as to cause a separation of their fibres. Other

[illegible] may be subjected [illegible] muscles attached [illegible] such position [illegible] disadvantage, as it [illegible] being prevented.

[illegible]

[illegible] and

[illegible] of

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contraction by the bone in its integrity is, after fractures, partially or entirely destroyed, and, as a result, displacement occurs in the direction of the muscular action.

Direction of the Displacement.—The displacement may be *longitudinal*, *angular*, *transverse*, or *rotatory*.

The *longitudinal* displacement is in the direction of the long axis of the bone, and causes, according to the bone involved, either shortening or lengthening; the former occurs most frequently in the fracture of the long bones where the line of separation is oblique and the ends of the fragments, as the result of muscular contraction, overlap each other; it also exists, to a less degree, in cases of *impacted* fracture.

Lengthening, due to longitudinal displacement, is observed in fracture of the patella where the fragments are separated by muscular action.

In *angular* displacement the fragments are placed at an angle to each other; the fracturing force, assisted by muscular action, produces this form of displacement; the angle, usually obtuse, may be increased in rare instances to nearly that of a right angle by the superincumbent weight of the body as in fracture of the femur, and union take place in this position.

Displacement in the *transverse* direction occurs in fractures in which the line of fracture is transverse and the ends of the fragments are only partially separated.

Rotatory displacement is that form in which one of the fragments rotates upon its axis so as to change the relative position of the surfaces; it may take place in either fragment, and is the result of muscular action alone, or that combined with the weight of the limb.

3d. The weight of the part of the limb below the seat of

[illegible] contributes to de-
[illegible]

[illegible] the movement which exists be-
[illegible] and is a character-
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The eye, the ear, and the hand should be employed in the examination. Interrogations as to the manner in which the injury was received: inspection of the injured limb or part; comparison with the sound side as to function, contour, position, and relation of prominent surface markings; measurements from fixed points, and finally manipulation to ascertain mobility and elicit crepitus—all of these should be made in a careful and systematic manner. The examination should be made as soon after the receipt of the injury as possible. It is necessary, in cases where the pain caused by manipulation is severe and the symptoms are obscure, to administer an anæsthetic, so as to avoid giving pain and to overcome muscular resistance. In order to elicit crepitus, the ends of the fragments should be brought into apposition, the part grasped firmly above and below the seat of fracture, and *gentle* movement should be made in different directions. In fracture of the ribs crepitus can be sometimes felt and heard by placing the hand and then the ear over the seat of suspected fracture. In compound fractures the finger can be introduced into the wound and the seat of fracture explored. In all manipulations required to establish the diagnosis, the utmost gentleness consistent with thorough examination should be practised in order to avoid the infliction of additional injury.

PROGNOSIS IN FRACTURES.

The prognosis as to the results after fractures, depends upon the age, condition of health, and habits of life of the patient, his co-operation with the surgeon during treatment, and the nature and extent of the fracture. The processes of repair in bone are favored by the vital energies of youth, robust health, and correct habits of life. A very important

element of success is perfect obedience on the part of the patient to the rules of treatment prescribed by the surgeon. In cases in which the directions of the surgeon are not followed by the patient, it is desirable to call a fellow-practitioner in consultation, in order that he may, in the event of the occurrence of a bad result, be able to bear testimony to the treatment instituted and thus exonerate the surgeon. The nature and extent of the injury influence largely the result. Fractures of bones of the trunk which enter into the formation of cavities, as the vertebræ, ribs, pelvis, are liable to be complicated with injuries of the contained viscera and thus render the prognosis unfavorable. Compound and complicated fractures in any part of the body, and fractures near to or into an articulation, involve a doubtful prognosis.

Process of Repair in Fractures.—The parts involved in the fracture of bones are the external covering, the periosteum; the bone tissue proper, compact and cancellous; and the medulla, with its membrane, the medullary membrane or internal periosteum. For the purpose of convenient study the processes concerned in the repair may be divided into stages.

1st Stage. In all fractures an extravasation of blood to a greater or less extent occurs as a result of the laceration of the blood-vessels of the tissues involved. The removal of this extravasated blood may be accomplished by absorption, removal by suppurative action, or it may become organized and form part of the reparative material.

2d Stage. The second stage includes all of the processes which are concerned in the union of the fragments, and may be designated the "uniting stage." After the removal of the extravasated blood is accomplished, or while this is being effected, the true reparative material begins to be formed,

the periosteum and the medullary membrane taking active part. This material, known as callus, appearing first as a granular substance, may, according to circumstances, pass through several transitional forms before ossification is accomplished, as fibrous tissue, fibro-cartilaginous tissue, and cartilage, or it may be transformed from rudimentary states directly into bone. It is deposited by the osteo-genetic layer of the periosteum about the external surfaces of the ends of the fragments forming the *external* or *ensheathing* callus, within by the medullary tissue forming the *internal* or *pin* callus, and, finally, by the bone tissue between the ends of the fragments constituting the *intermediate* or *definitive* callus. The extent of production and deposit of this callus depends upon the adjustment of the ends of the fragments and their maintenance in a fixed position. Accurate coaptation of the extremities of the fragments and absolute immobility reduces its production to a minimum degree by the protection afforded the lacerated surfaces by their coaptation and the prevention of irritation by immobility. In compound fractures where the wound is exposed to the air, and more or less suppuration occurs, the callus or reparative material is developed through the medium of granulations, which finally undergo ossification.

In some cases an arrest in the complete development of the reparative material may take place and the fragments may be united by fibrous tissue forming an *ununited* fracture.

3d Stage. This stage in the repair is occupied in the "modelling" or shaping of the parts about the seat of fracture. If the coaptation has been accomplished accurately, and the fragments kept quiet, there is little to be done in this stage. If the adjustment has been imperfect, the frag-

[illegible] [illegible] and the medullary tissue exposed, the work of this stage will consist in the removal of excessive callus if present, and the rounding off of the sharp ends of the fragments by absorption, the capping of the exposed ends of the fragments by new bone formation, the shaping of the callus [illegible] between the fragments and the formation of an external wall and a cancellous interior for it continuous with the [illegible] and, finally, the restoration of the medullary canal.

The time required for the completion of the reparative process varies according to the bone involved and the nature and extent of the fracture. In simple fractures the first week after the injury is occupied in the removal of the inflammation which is consequent upon the injury to the [illegible] and its [illegible]. From this period to the end of [illegible] the formation of the callus and its gradual [illegible] after the third week, and to the tenth [illegible] is perfected and the fragments are [illegible].

[illegible] OF FRACTURES.

[illegible] includes the transportation of [illegible] the bed, the reduction or setting [illegible] in place until union is accomplished, and, finally, the treatment of all conditions [illegible] period of repair.

[illegible]—In fractures other than [illegible] it is necessary that the patient [illegible] treatment. When the distance [illegible] in a vehicle of some kind, [illegible] car, in which the recumbent [illegible] maintained. If transported by hand he

should be placed upon a door, shutter, or settee, and this borne upon the shoulders of four strong men. Some soft and firm substance, as pillows, mattress, comfortables, or blankets, should be placed under the body and fractured limb or part, and this should be supported by temporary dressings so as to fix the fragments and prevent injury and pain. In the lower extremity the sound limb can be utilized as a splint, the injured one being bound firmly to it by large handkerchiefs, or broad strips of muslin applied at two or more points in figure-of-8 manner. Fractures of the pelvis, the vertebræ, or ribs, can be held in position during transportation by broad pieces of muslin, such as pillow or bolster cases carried about the body once or twice. The bones of the head and face can be supported by handkerchiefs applied in cravat form.

In fractures involving the upper extremity, including scapula and clavicle, the limb should be supported in a sling formed of a broad handkerchief in triangular form.

Preparation of the Bed.—The bedstead should be strong, and the mattress tightly stuffed so as to be firm and unyielding. A single or narrow iron bedstead, without a foot-rail, with short legs, and a firm hair mattress, is the best which can be selected for the patient suffering from fracture. In cases of fractures of the pelvis, vertebræ, or lower extremity, it is necessary that arrangements should be made for evacuation of the bowels without movement, and to accomplish this most successfully, a round opening should be made in the mattress and overlying sheet, beneath which the vessel for the reception of the feces can be placed. The surfaces and borders of the opening in the mattress should be lined with oilcloth, and the piece cut out should be covered and prepared so as to fit into the opening tightly, being placed in

position from beneath when not needed for use. In the iron bedstead the spaces between the slats are wide enough, and the vessel can be brought sufficiently near by placing it on a board or block so as to obtain proper evacuation of the feces.

A narrow wooden bedstead, with slats, can be arranged and used in the same way, or changed by introducing a board slat in the middle, with an opening in it, and cleats attached beneath, so that the vessel for reception of the feces can be slid into place and withdrawn after use. If neither of these are available, the ordinary rope bedstead, now largely out of use, can be made suitable by substituting slats which can be nailed to the rails, upon which a firmly packed straw or husk mattress, covered, if necessary, with [illegible] to make it firmer, can be placed. Where no opening is made in the mattress the bed-pan can be placed in position without causing much, if any, motion.

In cases where it may be necessary to employ the air or water-bed, a [illegible] substitute for those found in the shops may be [illegible] following way: a trough the length and [illegible] single bedstead, one foot and a half deep, [illegible] and then covered with a stout rubber [illegible] firmly secured to the sides. Upon [illegible] can be placed, and the patient made [illegible].

Whatever form of bed is selected, whether such as the patient is well able to provide, or such as is available to the poor, it should be the duty of the surgeon to have it made so as to afford firm and even support to the fractured limb or part, provided with appliances for the ready evacuation of the bowels without imparting movement, and in

every way conduce to the comfort of the patient, who is compelled to occupy it for a long period of time.

To remove the weight of the bedclothing in cases of fractures of the lower extremity, a rack or cradle should be provided: two half hoops crossed and fastened will serve the same purpose.

Removal of the Clothing.—The clothing of the patient should be removed with as much gentleness as possible. If it is necessary to cut it, this should be done in the seams so that they can be repaired readily. A little care and tact will enable the surgeon or his assistants to remove any or all of the articles of clothing without giving unnecessary pain or causing disturbance of the fragments. When the patient is in bed, the underclothing should not be drawn beneath the buttocks, as it is liable to become rumpled or folded in this position, causing discomfort and pain, conducing to the formation of bed-sores, and also it is more liable to become soiled.

Changing the Bed-linen.—The sheet overlying the mattress should be removed by drawing it from above downwards. Being first loosened at the top of the mattress and pushed down beneath the shoulders, the clean sheet is folded and carried under the shoulders to the same point, the upper end being placed in position under the mattress at the top. While the pelvis of the patient is raised gently, the soiled sheet, having been fastened with pins, or better, by stitches at two or more points in the middle to the clean sheet, is drawn down in this way, placing the latter in position. The sheet covering the mattress should be firmly stretched over it and secured by pins at the sides and top so as to prevent folding.

Reduction or Setting of the Fragments.—This consists in adjusting the ends of the fragments to as nearly as possible

splint can be obtained usually as will meet the indications present.

Binders' Board.—This substance, which, as its name indicates, is used by book-binders for making book covers, is, in common with card-board and pasteboard, employed to great advantage in the [illegible] of splints. These materials are valuable by reason [illegible]eir cheapness and their presence in the house of pati[illegible]n some form, and of the ease with which they can be s[illegible]d by immersion in water, preferably that which is hot, a[illegible] time of application, and immediately moulded upon [illegible]. Caution must be exercised with regard to the le[illegible]ime of immersion of the material, as it becomes too mo[illegible]ftened and separates into pieces if kept for too long a time in water. Especially does this caution apply to the thinner substances, as card-board and pasteboard. Usually it is sufficient to dip the pieces in the water once or twice, and then mould them to the part. Splints made of these materials should be padded with a layer of cotton-wool, or some thick, soft substance, and then retained in position by turns of the roller. They dry readily, and form a firm and well-adapted support to the adjusted fragments. Binders' board is to be used in cases of fracture of large bones, and in adults, while the pasteboard affords sufficient support in small bones and in fractures occurring in young children.

Paper.—Strong paper, such as is used in hardware and other stores for wrapping purposes, can be cut into pieces and fastened together by starch, white of egg and flour, or gum Arabic, thus forming a firm and stiff support. The pieces may be made so as to quite surround the limb, or cut into strips and placed as lateral supports.

Sole-Leather.—This substance is well adapted for the

[redacted]

purposes of forming splints by reason of its flexibility and firmness. It should be cut into pieces of suitable size, and after being soaked it can be easily adapted to the limb. In twelve to twenty-four hours it will become hard and can be removed, and the dressing readjusted. In order to prevent undue pressure by the edges and corners of the splint, these should be bevelled and rounded. It should be padded with layers of cotton-wool or soft woollen cloth. Strips of light wood can be glued to the surface of thin calf-skin or buck-skin, and in this manner combine the additional firmness of the wood with the flexibility of the leather.

Gutta-Percha.—Owing to the difficulties which attend the successful manipulation of this substance in the formation of splints, it has fallen somewhat into disuse. For the construction of the inter-dental splint in cases of fracture of the lower jaw and alveolar process of the upper it is of the greatest value. For this purpose the vulcanized India-rubber is regarded as less adapted. The ordinary gutta-percha can be softened by immersion in hot water and moulded to the parts as in other fractures.

Care should be taken always to place the sheet of gutta-percha upon a piece of strong muslin of sufficient width and length to enable it to be handled [illegible] moistened with the hot water [illegible] tray in which it is placed and to the fingers of the surgeon.

Felt.—This material has been employed [illegible] by Dr. A[illegible] of York, Pa. [illegible] which are formed on the shape already adapted [illegible] different parts of the body. It consists of wool or [illegible] impregnated with size or gum shellac and [illegible]. Dr. Hamilton describes [illegible]

splint can be obtained usually as will meet the indications present.

Binders' Board.—This substance, which, as its name indicates, is used by book-binders for making book covers, is, in common with card-board and pasteboard, employed to great advantage in the formation of splints. These materials are valuable by reason of their cheapness and their presence in the house of patients in some form, and of the ease with which they can be softened by immersion in water, preferably that which is hot, at the time of application, and immediately moulded upon the part. Caution must be exercised with regard to the length of time of immersion of the material, as it becomes too much softened and separates into pieces if kept for too long a time in water. Especially does this caution apply to the thinner substances, as card-board and pasteboard. Usually it is sufficient to dip the pieces in the water once or twice, and then mould them to the part. Splints made of these materials should be padded with a layer of cotton-wool, or some thick, soft substance, and then retained in position by turns of the roller. They dry readily, and form a firm and well-adapted support to the adjusted fragments. Binders' board is to be used in cases of fracture of large bones, and in adults, while the pasteboard affords sufficient support in small bones and in fractures occurring in young children.

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Care should be taken always to place the strip of gutta-percha upon a piece of strong muslin of sufficient width and length to enable it to be handled conveniently before it is moistened with the hot water, otherwise it will adhere to the tray in which it is placed and to the fingers of the surgeon.

Felt.—This material has been employed quite extensively by Dr. Ahl, of York, Pa., for the formation of splints, which are found on the shops already shaped for different parts of the body. It consists of wool, or wool and fur, moistened with size or gum shellac and then pressed into sheets. Dr. Hamilton describes an excellent substitute, and one which is

much cheaper, made from four to six layers of cotton cloth saturated with gum shellac and smoothly pressed.

Metal Splints.—Metals of various kinds, as tin, zinc, lead, sheet iron, iron wire, and copper, have been employed for the purpose of making splints. The weight of these materials and the time required to fashion them into proper shape, make their selection undesirable.

Plaster of Paris.—This, with starch, dextrine, and other substances possessing similar properties, is largely used in the formation of fracture dressings. They are designated as the immovable dressings. Latterly these dressings have been applied in such manner as to render them easily re-

Fig. 89.

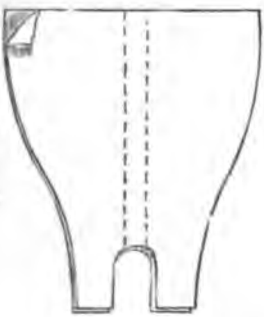


Fig. 90.

moved and at the same time not interfere with their character as well adapted and firm supports. In this condition they are called *movable-immovable* dressings or apparatus (Figs. 89 and 90). While this form of dressing possesses

many advantages, it is not entirely free from danger, as the recorded cases of bad results bear testimony. In cases of very simple fractures, unattended by injury of the soft tissues, it may be safe to apply immediately the immovable dressings. On the other hand, in cases of fractures which are the result of great violence, and in which the soft structures are much contused with a tendency to the production of inflammatory swellings, these dressings should not, as a rule, be applied immediately; if so applied, they should be watched with the utmost care, being so arranged as to be removed at intervals with ease and the parts inspected. When applied in the treatment of compound fractures, an opening or "trap-door" should be made over the wound so as to permit of the free escape of the discharges and of the application of suitable dressings (Fig. 91). In cases of

Fig. 91.

compound fracture or excision of joints or bones in which it is necessary to treat large wounded surfaces, plaster splints may be applied in sections and the two united by bars of wood or metal (Fig. 92).

In the employment of any splint, it matters not of what

material it is made, great care should be taken always to pad it well or place between it and the surface layers of

Fig. 92.

some soft substance in order that a proper adaptation to the inequalities of the limb may be secured, proper support afforded, and undue pressure avoided.

Splints may be padded conveniently by placing over the inner face or that to be applied to the surface, a sufficiently thick layer of cotton-wool, oakum, curled hair or other substance of like character, and holding it in place with a roller applied by spiral reverse turns and recurrent turns over the ends. Another method of padding consists in placing the splint in a muslin sock open at both ends into which the cotton-wool or other material is stuffed, in this manner forming a soft and firm cushion upon the side which is placed in contact with the limb. In all cases it is desirable to cushion the splint rather than apply a separate cushion or pad of loose material between it and the limb. These are liable to become displaced, or to lose their accurate adapta-

tion to the part. Sometimes masses of cotton-wool may be employed to fill up spaces between the splint and limb so as more completely to protect the part and afford support; as a rule their use should be avoided, or they should be used only to supplement the cushioned splint.

In order to retain the splint in position the roller should be applied with sufficient traction to accomplish this object without making undue pressure. In some instances, where a tendency to displacement exists it may be found necessary to apply the retaining bandage with more firmness, but great caution is to be exercised in order to avoid making too much traction, in this way causing interference with the circulation and possible gangrene of the limb. As in the application of the roller, where it is used as a primary or independent dressing, the sensations of the patient should be consulted, and the condition of the distal portions of the limb should be examined carefully and repeatedly.

As far as possible fracture dressings should be simple in construction, the materials composing them cheap and readily obtained, they should be comfortable to the patient, easily applied and removed. They should be made as light in weight as is consistent with proper support. Heavy and cumbersome dressings are apt to prove fatiguing to the patient and to provoke an unrest of the parts which may interfere with the reparative process. Elaborate and complicated dressings are not only difficult of application, but are liable to become disarranged, and in this way to cause displacements of the fragments with resulting deformities.

Sand-bags.—Bags made of strong muslin, and of suitable length and width, filled with dry sand, are used to afford lateral support in fractures of the lower extremities.

Adhesive Plaster.—This material is used in fractures for

the purpose of affording support, and in the lower extremity to secure extension (Fig. 93).

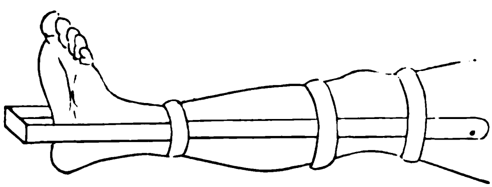
Weights and Pulleys.—These are employed to maintain extension in the treatment of fractures of the femur. The

Fig. 93.

Fig. 94.

Fig. 95.

Fig. 96.



pulleys can be adjusted by a simple arrangement to the foot of the bedstead, or on an upright frame (Fig. 94), and bricks, pound weights, or shot can be used as weights.

The cord holding the weights is fastened to a block which is secured in position between two pieces of adhesive plaster (Figs. 95–96).

When this method is used, counter-extension is obtained by raising the foot of the bedstead so that the body of the patient becomes the counter-extending weight.

Time for Reducing a Fracture.—The reduction and dressing of a fracture should be accomplished as soon after the occurrence of the injury as possible. If delay has occurred until severe inflammatory action is present, then a temporary dressing should be applied and sorbefacient lotions, as laudanum and lead-water, should be used locally. On the subsidence of inflammation reduction should be effected and a permanent dressing applied.

In cases where dressings are not at hand so that they can be applied immediately, the limb should be placed in a comfortable position and the fragments held by a temporary dressing.

Renewal of the Dressings.—The condition of the limb or part, and of the dressings, will be the guide to be followed in the renewal of the dressings. In fractures, other than those of the lower extremity, it is a safe practice to remove the dressings at the expiration of twenty-four hours, inspect the parts, so as to ascertain whether the adjustment is proper, and renew the dressings carefully. Especially is this necessary where there is pain, swelling, or other evidences of undue pressure. In the lower extremity the parts can be inspected usually without removal of the splints, and any constriction which may exist can be relieved. After the first day the outer dressings can be renewed every forty-eight hours, if necessary, for the first week or ten days. After this the dressings should not be disturbed as long as

they are in proper position. It should be remembered that perfect quietude of the fragments is essential to speedy and proper union, and that frequent renewals of dressings are liable to disturb them, and should, if possible, be avoided. During the entire course of treatment vigilance should be exercised, and the part kept under close observation, daily visits being made until the process of repair is well advanced. At the time of renewal of the dressings the limb should be firmly and carefully supported by assistants, so as to prevent displacement, and the surface should be sponged with dilute alcohol or soap liniment, and then dried thoroughly.

Removal of Dressings.—The limb involved and the nature of the injury determine the period at which it is safe to remove the permanent dressings. They should be retained from four to six weeks in fractures of the upper, and from five to eight in the lower extremity. After their removal, in all cases, bandages should be applied to afford support while the limb resumes gradually and carefully its functions. The part should always be examined carefully to ascertain that union is perfect before the permanent dressings are dispensed with.

Passive Motion.—The absolute rest essential in the treatment of fractures subjects the articulations contiguous to the bones involved to disuse, and as a result they become stiff and rigid. To overcome this impairment of function, *passive motion*, producing flexion, extension, or rotation if necessary, should be instituted gently and carefully at the expiration of from eight to twelve or fourteen days, and should be repeated at short intervals. The efforts necessary to accomplish movement of the joint should be made very cautiously, and the limb should be supported firmly by the assistants. Frictions with emollient and stimulating lotions,

as oil, dilute alcohol, soap liniment, and other agents of this character, should be made over the joint. When the fracture extends into a joint greater care is required in practising passive motion so as to avoid separation of the fragments. In these cases it should be persevered in, in order, if possible, to prevent anchylosis.

Conditions occurring during the after-treatment.—Muscular spasm, due to the irritation produced by the jagged ends of the fragments, is controlled best by hypodermic injections of morphia, one-sixth to one-quarter of a grain.

Contusions and Extravasations.—When these conditions are present to any marked degree the limb should be enveloped in cloths saturated with evaporating lotions. They may be applied with the dressings in position, or, in severe cases, it may be necessary to defer the application of the permanent dressings, placing the limb temporarily on a pillow, and continuing the use of the lotions until the inflammation subsides.

Gangrene.—This grave condition may occur as the result of arterial or venous obstruction, which may be due to the injury or to the pressure caused by tight bandaging. When caused by the latter, the treatment consists in the prompt removal of all constriction, with the hope of limiting the morbid action. If the gangrene becomes complete, amputation should be performed, at the line of demarcation, if one is present; or, in the spreading variety, a point some distance beyond the limits of the disease.

Excessive Inflammation, Erysipelas, Tetanus, Surgical Fever and Pyæmia are conditions which may occur after fracture, and require treatment as in other affections.

TREATMENT OF COMPLICATED FRACTURES.

Rupture of the Main Artery sometimes occurs as a complication in fracture. It is a serious accident, and is diagnosticated by the rapid swelling of the limb and the absence of pulsation in the arteries below the seat of injury. Frequently an ill-defined pulsation exists in the swelling. An effort to save the limb may be made by ligating at once the artery above the seat of injury. If the collateral circulation is not re-established gangrene will develop, when amputation must be performed.

Injury of Important Nerves.—Paralysis, partial or complete, is liable to follow injury of principal nerves in fracture, and should be treated by electricity, frictions, and other means, with a view to restore the lost power. If recognized at the time of the injury, the patient should be informed of the unfavorable prognosis. Repair of the fracture is not interfered with.

Involvement of an Articulation.—The treatment of a fracture implicating a joint requires great care, as the injury may be followed by anchylosis. In the large joints the condition may demand excision or amputation.

Dislocation accompanying Fractures.—The dislocation of an adjoining articulation sometimes occurs. Temporary splints should be applied, so as to support the broken bone, the luxation reduced, and then the fracture should be permanently dressed.

Fractures occurring in persons suffering from delirium tremens, epilepsy or chorea, are seriously complicated, and the treatment demands special care. In cases of *mania a potu* the patient should be strapped to the bed, and a well-padded splint of binders' board or felt should be moulded to

the limb and secured with a bandage. Appropriate remedies should be given to relieve the delirium. In patients suffering from epilepsy the fracture should be well supported by proper splints and the patients should be kept under the influence of bromide of potassium. The treatment of fracture in choreic patients is very unsatisfactory, owing to the impossibility of keeping the fragments at rest. In a case reported by Dr. Wm. Hunt of this city, death occurred on the tenth day from exhaustion.

TREATMENT OF COMPOUND FRACTURES.—In the treatment of compound fractures the question of amputation is always to receive consideration. The operation is, as a rule, demanded in those cases in which extensive injury is done to the soft tissues; large arteries wounded; large joints implicated, or where the bone is greatly comminuted. It should be performed as a primary operation before inflammation has supervened; if delayed until this period it should not be done until suppuration is fully established. In all cases the surgeon should exercise the best judgment, considering carefully the conditions presented in each case and the chances afforded the patient in an effort to save the limb.

In cases in which amputation is not required, an effort should be made after reduction and the application of proper splints to convert the fracture into that of the simple variety by closing the external wound. This may be accomplished where the wound of the soft structures is small, by the application of adhesive plaster, collodion and gauze, antiseptic dressings, or a piece of lint saturated with the blood from the wound. After closure of the wound it should be carefully watched, in order to ascertain whether pus is accumulating beneath the dressings. In the event of its formation the dressings should be immediately removed and the escape

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of the discharges promoted. In large wounds no effort should be made to obtain permanent occlusion. Appropriate dressings should be placed over the wound, and precautions should be taken to secure *free* drainage. The splints and bandages should be applied so as to admit of ready inspection of the wound without disturbance of the limb or part, and should be protected by oiled silk or waxed paper, so as to prevent soiling by the discharges.

Reduction is accomplished, as in simple fracture, by extension, counter-extension, and manipulation. If the fragments project through the wound, their reduction may be facilitated by the administration of an anæsthetic agent and placing the limb in such position as to cause relaxation of the muscles, and by separating the edges of the wound with retractors; or, if necessary, the wound may be enlarged by an incision. Resection of the projecting fragments should be performed only when all other means of reduction fail, and then as small a portion as is absolutely necessary should be removed. If the periosteum is stripped off, as may happen most easily in young subjects, it should be replaced over the surface of the bone, in the hope that reunion will ensue and necrosis be thus prevented.

In compound fractures in which the bone is comminuted it will be necessary to remove the fragments or splinters which are completely detached. Those having sufficient periosteal attachment to insure proper blood supply should be carefully adjusted and allowed to remain in position. If sequestra are formed, they are to be removed as soon as sufficiently detached. The inflammation which ensues should be treated by the administration of such remedies, and the application of such dressings, as will control its effects upon the system and limit its extent. Antiseptic dressings, cold-

water applications, poultices, etc., may be employed locally, as the conditions of each case may demand, whilst iron and quinine, with stimulants, may be given to maintain the patient's strength under the suppurative action.

TREATMENT OF FRACTURES UNITED WITH DEFORMITY. —The deformity in such cases may be in the direction of the long axis of the bone resulting in overlapping of the fragments, in the transverse direction, causing angular displacement, or by rotation of the distal fragment.

In all of these forms the displacement may be overcome partially or completely by manipulation in the early stages of the process when the reparative callus is soft.

Union with overlapping of the fragments, or with overlapping and rotation of the distal fragment, is necessarily accompanied by shortening of the limb. In old cases of these forms of deformed union it is not desirable to attempt relief by treatment, as the muscles are in such a state of permanent contraction as to interfere with any efforts at extension of the limb.

In angular deformity, in the early stages of repair, from three to five weeks, the displacement may be removed by bending the part over the knee or the edge of a table, and the subsequent application of pressure so applied as to maintain the limb in a straight position. In cases in which the callus is so firm as to resist efforts of this character, re-fracture may be accomplished either by perforating the callus with a drill, dividing it subcutaneously and partially with an Adams saw, or with a chisel, removing a wedge-shaped piece of bone, and then applying force to complete the separation of the callus. Excision of the callus may be resorted to in extreme cases; but it should not be undertaken without a

full appreciation of the grave character of the operation, and of the possible failure to obtain subsequent osseous union.

One of the most remarkable cases on record of union with deformity is that depicted in Fig. 97, reproduced from woodcuts which were made for Mr. Jonathan Hutchinson, F.R.C.S. London, of a specimen examined by him in the Musée Dupuytren, Paris. The union occurred actually at right angles. Fig. 98 exhibits a second specimen from

Fig. 97.

Fig. 98.

the same source in which the angle is less than in the first, but showing still greater deformity. This specimen, as stated by Mr. Hutchinson, possesses unusual interest as having been deposited in the Museum by M. Malgaigne, a short time before his death, and is, perhaps, "one of the last results of that surgeon's unwearied zeal for science."

Ununited Fracture, or Pseudo-arthrosis.—Non-union of a fracture may occur as the result of constitutional and local causes. The former includes such conditions as have a tendency to diminish the vital powers, as hemorrhage, shock, age, and diathesis. The local causes relate to the presence of some foreign body, as a piece of necrosed bone, between the fragments, or the failure to obtain the necessary immobility of the parts, either by the improper application of dressings, the absence of co-operation on the part of the patient, or his interference with the dressings. Non-union after fracture occurs in the large bones of the skeleton, and most frequently in the femur and humerus. Its existence may be established if mobility is present between the fragments six to eight weeks after the period when consolidation should have taken place. In non-union the ends of the fragments undergo various changes; they may become rounded or conical, and be separated by a distinct interval, or the ends may be united by bands of fibrous tissue, which inclose them in a capsule, in some instances the interior of the sac being lined by a membrane which secretes a fluid analogous to the synovia. Again, one extremity may be rounded and the other present a cavity into which the former rests, forming a joint which resembles the ball-and-socket variety.

In the treatment of delayed union attention should be paid to the constitutional as well as to the local conditions which are present. Remedies which will invigorate the system and contribute to bone production should be administered, such as the tincture of the chloride of iron and preparations of the phosphates. Complete immobilization of the fragments should be secured by plaster dressings which will permit the patient, at the same time, to obtain the benefit

of exercise in the open air. By these means, the formation of the false joint may be averted, and the union, although delayed, may be complete.

Various plans of treatment have, from time to time, been suggested and put into practice to obtain osseous union after the establishment of the false joint. Among these are friction; the production of irritation, both external and internal; the use of the seton; union of the fragments by means of pegs and wire after the drilling of the fragments; application of caustics and actual cautery to the ends of the fragments; and, finally, resection and approximation of the ends.

Friction is accomplished by rubbing the ends of the fragments forcibly against one another, and placing the limb in immovable dressings so as to obtain perfect rest. This manipulation may be repeated if necessary. An apparatus has been devised by Prof. H. H. Smith, which maintains continuous friction between the ends of the fragments and permits the patient to walk

Irritation over the seat of fracture has been practised, using, for this purpose, blisters and caustic potash.

Internal irritation may be accompanied by the injection, through a canula, of tincture of iodine, nitric acid, or solutions of nitrate of silver. Acupuncture needles have been introduced between the fragments to produce irritation, and to these have been attached the poles of a battery. Scarification of the ends has been performed by tenotomes introduced subcutaneously.

The *seton* may be used with advantage in pseudo-arthrosis occurring in certain bones. It should be carried near to the seat of fracture, or between the fragments, and should remain sufficient time only to excite irritation; the production of prolonged suppuration should be avoided—fatal results have

attended its use in ununited fractures of the femur; care should be taken to avoid large bloodvessels and nerves in the passage of the needle.

Drilling the fragments and fixation by the introduction of pegs and screws. Various forms of pins and screws have been employed to accomplish union by this method. Dieffenbach introduced ivory pegs, after drilling a number of holes into the fragments, and then held them together. Steel rods, with gimlet points and with threads cut upon the shaft, have been passed through the fragments and allowed to remain in position until union has been accomplished.

Resection of the fragments has been performed, and the sawn ends brought into apposition, and so maintained by appropriate means. In some instances, the ends have been drilled, and wire sutures introduced, so as to hold the fragments more securely in apposition.

Exposure of the ends of the fragments, and the application of nitric acid, caustic potash, and the actual cautery have been practised in some cases.

Of these different methods of treatment the use of the seton and resection of the fragments have, according to the tables prepared by the late Dr. George Norris, of Philadelphia, accomplished the best results, although fatal results have occurred in some of the cases treated by these methods. The plan of producing friction by rubbing the ends of the fragments forcibly together has also achieved very favorable results—without the occurrence of deaths. Cases in which this plan failed were treated subsequently by resection and the seton with success. Varied results have attended the employment of the other plans of treatment; in some instances, successful results have followed; in others, failures; and in still others, death has occurred. The general intro-

duction and use of antiseptic methods of wound treatment will, Prof. Agnew states as his belief, disarm resection of its danger, and lead to its practice with good results.

SPECIAL FRACTURES—SKULL.

CRANIUM.—Fractures of the cranium may occur on the vault or at the base, and may be simple, compound, or complicated. They may be also classified with regard to the degree of penetration into complete and incomplete, in the former both tables of the bone being fractured, and in the latter but one—either the external or internal.

Causes.—The causes of fracture are force applied directly, producing fracture either on the vault or at the base, such as

Fig. 99.

blows with a bludgeon, axe, or sabre, falls upon the head, or gunshot wounds. Figure 99, an illustration of a specimen

in my possession, exhibits the results of blows with the pole of an axe, involving on the right side the temporal, frontal, parietal, and occipital bones, with almost entire destruction of the temporal and sphenoid, with the basilar process of the occipital at the base. On the left side a blow over the frontal bone just above the supra-orbital arch has produced a fracture which extends upward to the fronto-parietal suture and downward through the orbit into the superior maxillary, palate bones, and pterygoid process of the sphenoid. Over the squamous portion of the left temporal there is a short line of fracture, and over the left side of the occipital bone there is an opening made by the cutting edge of the axe, chipping out a portion of both tables. The subject in whom these extensive fractures were received was a young woman who, while asleep, was murdered by her paramour.

Blows upon the cranium may produce fracture of the internal table without injury to the external, forming in this way an incomplete fracture.

Repair of fracture of the cranial bones takes place by the formation of an intermediate fibrous tissue which may undergo ossification.

Symptoms.—The symptoms in cranial fractures relate rather to the brain than to the conditions of the bone. In simple fractures there are usually no symptoms indicating the nature of the injury. In fractures complicated with depression of the fragments, the symptoms of cerebral compression may be present if the depression of the fragments is sufficient to exert pressure. Cerebral concussion may follow in both simple and complicated fractures as the result of the force applied in producing the fracture. Hemorrhage from the nose, intra-orbital ecchymosis, and bloody

tion of the parts in order to elicit crepitus and establish the existence of mobility. Swelling, deformity, and epistaxis may be present without fracture. It is of the utmost importance to avoid the occurrence of deformity in the treatment of fracture of these bones, and hence the examination should be thorough, placing the patient if necessary under the influence of an anæsthetic agent in order to secure quietude during the necesssary manipulations.

Prognosis.—The prognosis relates to the occurrence of deformity which may be avoided by careful reduction of the displaced fragments.

Treatment.—In simple fracture of the nasal bones, and where the nasal bones alone are broken, there is usually little or no displacement of the fragments, and the only dressing, if any is required, consists in the application of narrow strips of adhesive plaster, the extremities of which are attached to the sides of the face and the body moulded over the bones.

Fracture of the bones complicated with fracture of the nasal processes of the superior maxillæ, the nasal spine of the frontal bone, the perpendicular plate of the ethmoid, or the separation of the cartilages from their bony attachments, requires careful manipulation with a strong steel probe or female catheter introduced into the nostril and counter-pressure exerted by the finger applied on the outside, to effect adjustment of the fragments. Displacement is prevented by the introduction of a piece of English gum catheter of the proper length, which is packed about with pieces of old linen, or with iodoform gauze or cotton-wool. Prof. Agnew suggests the use of pieces of sponge shaped to fit the nasal cavity and covered with wax. The sponge soon swells and exerts pressure in such manner as to prevent displace-

ment. They may be removed after a period of twenty-four hours, and if necessary a second introduced.

MALAR BONE. *Cause.*—External force applied over the bone may cause fracture of the zygomatic process; if the force is very great, it may produce fracture of the body extending to adjacent bones, as the superior maxillary.

Symptoms.—The symptoms are contusion and swelling, pain, with deformity, and in certain cases mobility and crepitus.

Diagnosis.—The symptoms are usually sufficiently marked in severe cases to render the diagnosis easy. Pressure and counter-pressure by the index finger of one hand introduced into the cavity of the mouth, and that of the other hand placed on the outside over the bone, will determine the existence of mobility and crepitus.

Prognosis.—As far as repair is concerned the prognosis is favorable. Unless care is taken to restore the displaced fragments to proper position, more or less deformity will result.

Treatment.—Simple fracture of this bone is not accompanied by displacement of the fragments, and no dressings save compresses wet with a sorbefacient lotion are demanded. Fractures which are the result of great violence, involving the bones with which the malar articulates, produce displacement, which must be corrected by elevation, pressure, and counter-pressure, made, if necessary, by introducing the finger within the mouth. Gibson's or Rhea Barton's bandage (Figs. 45, 46) should be applied so as to secure immobility of the lower maxilla, and at the same time support the fragments.

SUPERIOR MAXILLARY BONE. *Causes.*—Securely fixed in position as this bone is, braced behind by the pterygoid

process of the sphenoid bone through the intervention of the tuberosity of the palate bone, and above and laterally by the temporal through the zygomatic arch and malar bone, it requires great violence to produce fracture of it. Fractures through the body are the result of force applied directly over the parts, as blows with a bludgeon, a brick, a base-ball, or crushes between the bumpers of a car. The alveolor process is more readily broken by reason of its exposed position. More or less fracture of the walls of the alveoli accompanies the efforts at the extraction of teeth; in instances which have come under my observation large portions have been detached by improper manipulation with the extracting forceps. Separation of the adjacent maxilla is a rare accident, and when it occurs it is the result of such violence as is likely to cause a fatal termination.

Symptoms.—In simple fracture of the body the symptoms are not very marked, there is little or no deformity, and crepitus cannot usually be obtained. An inspection of the cavity of the mouth will detect the line of separation through the palatine and alveolar processes. In fractures of the alveolar process the seat of fracture can be readily inspected.

Diagnosis.—The diagnosis is made by an inspection of the parts both within and without the cavity of the mouth; mobility and crepitus can be established by grasping the fragments when the fracture involves the alveolar process.

Prognosis.—The tendency to repair after fracture is so marked in this bone that the prognosis is extremely favorable. Ordinarily the displacement is so slight that little or no deformity follows repair.

Treatment.—In simple fracture of the body the dressings required consist of a bandage which will hold the lower jaw firmly against the upper so as to support the broken bone.

Of the processes displacement after fracture is more liable to occur in the alveolar, and appliances must be adapted to overcome this. Teeth which are completely dislocated should be cleaned and restored to position, and all comminuted fragments with displaced teeth should be moulded into position. Retention of the fragments in place is best accomplished by means of the interdental splint (Fig. 103) and Rhea Barton's bandage, the latter holding the lower jaw against the upper so as to afford support.

INFERIOR MAXILLARY BONE. *Causes.*—Blows given over the body or ramus may produce fracture of these parts. Falls upon the chin may cause fracture of the ramus or the condyloid process. Cases of fracture of the body have come under my observation, which were produced by efforts at extraction of the posterior teeth, especially the last molar or wisdom tooth.

The *Site of Fracture* may be in the body, ramus, or processes, and may be simple, compound, or comminuted in character. Owing to the subcutaneous position of the upper border of the bone the fracture is most frequently compound into the mouth.

Symptoms.—In fracture of this bone all of the signs of fracture are usually present. Pain and loss of function are usually marked with preternatural mobility, deformity, and crepitus. Escape of the saliva is also frequently present as a symptom.

Diagnosis.—Inspection of the cavity of the mouth will show the deformity due to the irregularity of the teeth, and mobility and crepitus can be ascertained by grasping the fragments within and without the mouth, and moving them over each other. Deformity is not marked in fractures of the ramus, owing to its muscular attachments. Pain felt in front of the

ear, with crepitus, which can be felt by placing the finger over the neck of the condyle, indicates fracture at this point.

Fracture of the coronoid process rarely occurs. Immobility of the fibres of the temporal muscle when the jaw is depressed would indicate detachment of the process.

Prognosis.—In most cases, union occurs without difficulty; in some, it is delayed, and in others necrosis interferes to prevent it. Slight deformity in the alveolar border is liable to follow in certain cases. Where the fracture is comminuted, great difficulty is sometimes experienced in effecting a favorable result.

Treatment.—The dressings for fractures of the body consist in the use of external and internal splints, with rollers to retain the jaw in position against the upper. In some instances it has been found necessary to employ wire or silk ligatures to surround the teeth, and thus hold the fragments in apposition. In still other cases, the bone has been drilled on opposite sides of the fracture, and wire sutures introduced.

External splints may be made of gutta-percha, sole leather, or binders' board, and so fashioned as to form a cup to re-

Fig. 100.

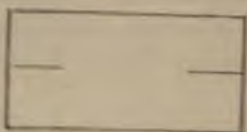
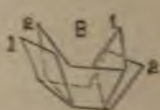


Fig. 101.



ceive the body of the jaw. Binders' board is well adapted to the purpose, and, after being shaped, should be immersed in hot water and moulded upon the part (Fig. 100). Care should be taken to pad the splint well with cotton-wool or

lint, so as to prevent excoriations and pain by undue pressure. The splint may be held in position by Gibson's, Barton's, or the four-tailed bandage. During the first week of treatment by this plan, the bandage, with the splint, should be removed every other day, in order that the external parts may be inspected, the fragments being, meanwhile, supported carefully by the hand.

Prof. Hamilton has devised an apparatus, which, in his experience, overcomes the disadvantages which follow the application of the external splint confined in place by the roller. It consists of a maxillary strap or band made of leather, and two counter straps—the occipito-frontal and vertical, made of strong linen webbing. The maxillary band is narrow under the chin, broader upon the sides of the jaw, and has a band of linen passing across the front of the chin to prevent it from sliding backwards. A pad must be placed beneath each buckle (Fig. 102).

Fig. 102.

Internal, or inter-dental splints, afford the best means of treating fractures of the body of the jaw. They may be made of metal, gutta-percha, or vulcanized rubber—preferably the latter—and in order that they should be adapted accurately to the parts, it is necessary that an impression of the mouth should be taken

with the fragments accurately adjusted. This impression should, if possible, be taken in plaster of Paris, and to do this properly, the services of a dentist should be invoked, who has all the appliances at hand, and is familiar with their manipulation. The splint, when applied, embraces the teeth of the upper and lower jaws, and extends some distance over the alveolar processes, so as to maintain the fragments in accurate apposition. An opening is left between the plates for the introduction of a glass tube for the purpose of taking liquid nourishment (Fig. 103). Perforations opening into the cavities of the splint should be made so as to permit the injections of cleansing fluids. This splint is held in posi-

Fig. 103.

Fig. 104.

tion by turns of the Gibson or Barton bandage. For the treatment of fractures of the bone occurring in edentulous persons, or where the teeth have been lost, Dr. Guernsey, a dentist of New York, has adapted steel branches to the interdental splint—a superior, which passes along the upper

part of the face, and an inferior, along the lower jaw; bands are employed to hold the splint in place—one passing under the chin, and one to the nape of the neck from the lower branch, and one secured to the borders of a cap which is worn over the head (Fig. 104).

Caps of soft metal may be fitted over the teeth, and serve to keep the fragments in apposition.

A mass of gutta-percha may be softened by immersion in hot water, and an impression made by placing them between the teeth, and carefully elevating the lower jaw, the fragments being previously adjusted. Hardening of the gutta-percha takes place in a few minutes, when the splint can be removed, fashioned into shape, and reinserted. Bandages are to be used to bind the jaws together.

The employment of silk or metal ligatures around the teeth to keep the fragments in place is objectionable, giving rise to pain and soreness in the teeth and soft tissues, and very frequently failing to accomplish the purpose intended.

In aggravated cases of displacement, drilling of the bone, and the introduction of strong wire sutures, may be necessary to obtain coaptation, and maintain the fragments in position.

In fractures of the angle, ramus, coronoid or condyloid processes, the dressings consist in the application of properly adjusted compresses over the parts, and the crossed bandage of the angle of the jaw (Fig. 41).

In fractures of either the upper or lower jaw, the dressings should be continued from five to six or seven weeks, and the mastication of hard substances should be avoided for some time after their removal.

LACHRYMAL, INFERIOR TURBINATED, VOMER, AND PALATE BONES.—Fracture of these bones occurs, as a rule, as a

complication with the fracture of adjacent bones, and requires no special description.

TRUNK.

HYOID BONE. *Causes.*—Constriction of the neck with a cord, or grasping the neck with the hand with violence, as well as blows over the site of the bone, may cause fracture. Muscular contraction has also been assigned as a cause by Dr. Hamilton, of New York, who has recorded a case in which it occurred

The seat of fracture may be in the body or cornua—in the former as the result of constriction by the cord as in hanging —and in the cornua by the forcible grasp of the hand.

Symptoms.—The symptoms of fracture of this bone are almost entirely rational in character. Great pain attends all movement of the parts attached to the bone, and as a result there is marked loss of function in so far as relates to speaking, deglutition, or opening of the mouth. Preternatural mobility, deformity, and crepitus are not usually present.

Diagnosis.—The impairment of articulation, deglutition, and movement of the lower jaw should direct attention to a possible fracture of the hyoid bone if occurring after any injury which would cause constriction of the neck over the site of the bone. Crepitus may be detected by the patient during efforts at swallowing, or it may be felt, as well as the displacement, by the surgeon on introducing the fingers into the pharynx.

Prognosis.—The result in fracture of the hyoid bone depends upon the character of the injury. If the fracture is simple, and there has been little contusion of the parts, union may take place without complication. On the other

hand, severe contusion of the parts, involving possible injury to the larynx, may result also in necrosis of the detached piece, the formation of an abscess, or displacement of one of the fragments, endangering the patient's life.

Treatment.—The movable character of this bone, accomplished by the attachment of numerous muscles, renders it impossible to secure coaptation and fixation of the fragments in case of fracture by the application of any dressings. Immobility can be alone obtained by maintaining the natural position of the head in its relation to the neck—neither flexion nor extension. For five or six days nourishment should be administered by enemata, and talking should be rigidly interdicted.

CARTILAGES OF THE LARYNX AND TRACHEA. *Causes.*—The same as in fracture of the hyoid bone.

The seat of fracture is most frequently in the thyroid cartilage—after this the cricoid.

Symptoms.—In addition to the symptoms present in fracture of the hyoid bone, there is bloody expectoration, emphysema of the neck, with partial or complete aphonia. Dyspnœa is always present as a prominent symptom, and is due in the earlier stage either to extravasation of blood or to displacement of the fragments. In the later periods it is due to inflammatory swelling or submucous infiltration. Mobility and crepitus may be present.

Diagnosis.—The diagnosis must be made by a careful study of the symptoms. They are usually sufficiently well-marked sooner or later to guide to a correct diagnosis.

Prognosis.—The prognosis is exceedingly grave; the danger, both immediate and more remote, which menaces the life of the patient is involvement to a fatal degree of the respiration through obstruction in the larynx. Of eighty-

nine cases reported by Prof. Agnew, in his work on surgery, twenty-two recovered and sixty-seven died.

Treatment.—As in fractures of the hyoid bone, no dressings can be applied in fractures of these cartilages which will in any way control the mobility of the fragments. The treatment should be conducted by position, nutritive enemata, and remedies to combat inflammation, and, if necessary, the prompt employment of laryngotomy or tracheotomy to relieve dyspnœa, and prevent a fatal termination.

VERTEBRÆ. *Causes.*—Violence directly or indirectly applied may produce fracture of the vertebræ: directly, as by the passage of the wheel of a wagon, or a crush between a wagon or car and the wall of a building; indirectly, by falls from a height upon the feet or head, or by the fall of a mass of earth upon the body producing extreme flexion of the column.

The *seat* of fracture may be in the body, arch, or processes.

Symptoms.—The prominent symptom in fracture of the vertebræ is paralysis, and this is due, if it occurs immediately after the receipt of the injury, to pressure upon the cord, exerted by the displaced fragments; or, if it occurs later, to the pressure made upon the cord by a blood-clot, by inflammatory exudations, or it may be due to softening of the cord.

The paralysis varies as to its extent in accordance with the site of the injury. Fracture with compression of the dorso-lumbar portion of the cord produces paraplegia with paralysis of the bladder and rectum. In the dorsal and cervical regions, fracture with compression of the cord involves the important functions of the intestines and respiration by producing paralysis of the abdominal walls, muscular walls of the intestines, and muscles of respiration.

In fracture of the spinous process deformity and crepitus may be present without paralysis; displacement is marked in fracture of the odontoid process of the axis. Pain on movement is also experienced in fracture at different points.

Diagnosis.—The difficulties of diagnosis relate largely to the point of fracture in the vertebra and to the region involved. In fracture of the spinous process the physical signs are usually sufficiently distinct to render the diagnosis easy. Fractures of the body, laminæ, articular or transverse processes are more difficult of detection by reason of the deep-seated position of these parts and the dangers which attend the manipulations necessary to establish the signs of fracture. The effects of pressure upon the spinal cord as manifested in the different regions and organs of the body supplied by the spinal nerves, must guide the surgeon largely in arriving at the nature and extent of the injury. The absence of symptoms of pressure of the cord by displaced fragments of the vertebræ should not be received as positive evidence of the non-existence of fracture, since the latter may exist with even some displacement without any or sufficient compression to give rise to pressure symptoms.

Prognosis.—In fractures of the vertebræ the prognosis is, as a rule, unfavorable owing to the injury liable to be inflicted upon the spinal cord and the results which follow such injuries.

Treatment.—In fractures of the vertebræ, whether of the body, arch, or processes, the patient should be placed in the recumbent and straight position on a firm mattress, with a soft pillow placed beneath the lumbar region, and in case of fracture in the cervical region pillows or folds of cloth should be placed alongside of the neck to afford lateral support. In

cases in which the injury is accompanied by paralysis of the lower extremities, or a loss of sensation in regions of the back, the patient should be placed upon a water-bed; if this cannot be obtained the prominent points should rest upon air-cushions or rings in order to remove pressure and prevent the formation of bed-sores. Where the expense of a water-bed prevents its use, a cheap and efficient substitute can be made in the manner described on page 130. Appliances to accomplish extension, or dressings to make lateral pressure, beyond those mentioned above, should not be employed. Careful attention to the bladder and bowels, as well as to the general condition of the patient, forms an important part of the treatment.

STERNUM. *Causes.*—The causes of fracture of the sternum are direct and indirect violence. The former includes blows upon the part, as the kick of a horse, or the passage of the wheel of a wagon. Indirect violence, resulting in fracture, may be applied in various ways, as falls from a height upon the head, feet, or buttocks. Muscular contraction participates, according to the belief of Prof. Agnew, in the production of fracture in these instances, as well as when it results in certain cases of parturition and in violent efforts at vomiting.

The *seat* of fracture may be at any part of the bone, or between the ensiform cartilage and the body.

Symptoms.—Pain, which is increased by any movements of the chest-walls, as in forced respiration or coughing, is a prominent symptom. Deformity is sometimes present, and crepitus may be heard by placing the ear over the bone during forced respiration; or it can be felt by placing the hand over the seat of fracture during chest movements.

Diagnosis.—Crepitus, heard or felt, with swelling, dis-

coloration, and pain, is sufficient usually to establish the diagnosis of fracture. Deformity cannot be always relied upon, owing to the congenital malformations which are so frequently present in this bone.

Prognosis.—In fractures which are not complicated by injury of the lungs or heart, the prognosis is favorable. Where these organs are involved serious complications may attend the fracture.

Treatment.—Reduction having been effected in case of displacement of the fragments, by extension of the body over a firm cushion or pillow, combined with elevation of the upper extremities and depression of the base of the thorax, a compress should be applied over the seat of fracture and the chest surrounded with spiral turns of a bandage from three to four inches wide. The turns of the roller should begin above, and should be applied with sufficient firmness to limit thoracic respiration. A broad band of Canton flannel bound firmly around the chest, and held by a band over the neck (Fig. 105), or adhesive strips, two inches wide, drawn over the compress and extending between the angles of the ribs, can be substituted for the spiral bandage.

Fig. 105.

Costal Cartilages. *Causes.*—Violence applied directly or indirectly, producing fracture in the transverse direction, and either near the sternal or the costal end. The cartilages most frequently affected are those of the seventh and eighth ribs. Of the cases recorded, the fracture appears to have

occurred in young persons, and not in those of advanced age, when ossification is supposed to have taken place.

Symptoms.—As in fracture of the sternum, pain is a marked symptom, and it is increased during forced respiration. Deformity due to the overlapping of the fragments is frequently present, with preternatural mobility and crepitus.

Diagnosis.—By manipulation, executing pressure and counter-pressure, the unnatural mobility can be distinguished, with the crepitus, which is somewhat indistinct and softer than bone-crepitus. It may sometimes be heard and felt, as in fracture of the sternum.

Prognosis.—Owing to the elasticity of the costal cartilages the force required to produce fracture of them is greater than that which may cause fracture of the sternum or ribs, and hence the liability of involvement of the organs contained within the chest with the consequent complications which may render the prognosis uncertain. Repair after fracture usually takes place by bone, although it may be by cartilage, as museum specimens have demonstrated.

Treatment.—In the treatment of fracture of the costal cartilages the dressing should be applied in the same manner as in fracture of the sternum, a compress over the seat of fracture, with adhesive strips applied over it, being sufficient, as a rule, to maintain the fragments in position.

Ribs. *Causes.*—The cause which is concerned in the production of fracture of these bones is the same as in fracture of the sternum and costal cartilage, viz., force directly and indirectly applied. Muscular contraction, as in severe fits of coughing, or violent muscular effort, may also cause fractures of these bones. When the force is applied directly over the part, the fracture occurs at the point of contact. Applied in the antero-posterior direction the bones yield at or near the

point of greatest convexity. The ribs most liable to sustain fracture are those between the third and eighth; the first and second being protected by the projection of the clavicle, and the eleventh and twelfth escaping by reason of their great mobility.

Symptoms.—In simple fracture of the ribs the symptoms, with the exception of pain, may not be well marked. Covered as they are by muscular structures, and held together by intervening muscles with strong aponeuroses, displacement to any extent is not liable to occur, and hence deformity is not present as a prominent symptom. Crepitus may be heard by placing the ear over the point of suspected fracture.

In complicated fractures the symptoms of the injury inflicted upon the overlying or intervening muscular structures or the lungs or heart intensify those of fracture of the ribs. In these cases hæmoptysis, intense pain owing to injury of the intercostal nerve, hemorrhage from wounding of the intercostal artery, pleurisy, pneumonia, or emphysema resulting from wounds of the pleura or lung may occur.

Diagnosis.—The diagnosis, in simple fractures owing to the absence of well-defined symptoms, is somewhat obscure. Crepitus may be detected by the ear or hand placed over the supposed seat of fracture. If overlapping of the fragments occur the displacement may be felt by passing the finger over the seat of fracture. In complicated fractures the careful study of the symptoms presented lead to the formation of a correct diagnosis.

Prognosis.—The prognosis is favorable in simple fracture. The nature of the complication, with the age and state of health of the individual, render the prognosis very doubtful in complicated cases.

Treatment.—The indication to be fulfilled by dressings in

fractures of the ribs is to so control the thoracic respiration as to secure rest of the broken bones. As displacement is usually very slight it is not necessary ordinarily to direct treatment to the relief of this condition. The best means of securing rest of the broken bone, as well as to overcome displacement if it should exist, is to apply strips of adhesive plaster over the side of the chest, two to two and a half inches wide, and long enough to reach from the vertebral column to the median line of the sternum. The application of these strips should begin two or more ribs above that fractured, and passing down cover it with the same number below. They should be applied parallel to the direction of the ribs, and one-half of the strip should be covered by that succeeding so as to present an imbricated appearance, and afford firmer support. (Fig. 106.) A wide bandage, made of Canton flannel or strong muslin, or the spiral bandage of the chest (Fig. 53), may be employed as in fracture of the sternum. In cases of bilateral fractures a plaster jacket may be applied with advantage over a thin knit flannel shirt, to prevent excoriation of the surface. Complicated fractures require that treatment should be directed to the conditions which accompany the fracture. If the fragments have penetrated the lung they should be elevated, and if necessary resection should be performed in order to relieve the pressure.

Fig. 106.

UPPER EXTREMITY.

CLAVICLE. *Causes.*—The causes which act in the production of fracture are direct and indirect violence, with muscular contraction. Direct force may be applied by blows with a bludgeon or the recoil of a musket, the butt being improperly placed over the bone at the time of firing, producing a transverse separation of the bony fibres. Indirect force may be transmitted by falls upon the hand, elbow, or shoulder, producing an oblique line of fracture. Fracture, as the result of muscular action, occurs, according to reported cases, when the arm is in a state of extreme extension.

Bilateral fracture of the clavicle is extremely rare. Incomplete fracture of the bone occurs frequently in children and young persons.

Symptoms.—Pain, deformity, and crepitus are present as symptoms of fracture of this bone. Loss of function is, as a rule, very marked, the patient being unable to grasp the opposite shoulder, or to make extended movements of the extremity; the shoulder is depressed, and the patient supports the arm of the affected side.

Diagnosis.—Crepitus may be elicited by manipulation of the shoulder and extremity, after placing the fragments in apposition. Carrying the arm upward, outward, and backward will accomplish this. Deformity can be seen, and the displacement of the fragments felt by passing the finger along the border of the bone. The displacement of the arm downward, forward, and inward is characteristic of fracture of the bone.

Prognosis.—In uncomplicated cases the prognosis is favorable, union taking place promptly; but, as a rule, with more or less shortening and deformity. Wounds of the sub-

clavian or jugular veins may occur, with paralysis of the arm, as the result of pressure of the fragments upon the brachial plexus of nerves, in complicated cases. The functions of the arm are not, as a rule, impaired where union takes place with shortening and deformity.

Treatment.—In the adaptation of dressings in the treatment of fractures of this bone, it is important that its function as a brace or stay-bone to the shoulder should be kept clearly in mind, and further, that the action of the muscles which are concerned in displacing the shoulder, and with it the upper extremity after fracture should be understood. The bones, firmly fixed as they are between the sternum and acromium process of the scapula, maintain the separation of the shoulders, and in this way contribute largely to the use of the upper extremities as prehensile organs. The stay being broken, the shoulder, and with it the attached upper extremity, falls inward, whilst the muscles which are attached to the scapula draw it downward and forward. The muscles acting directly upon the scapula in this action are the serratus magnus and pectoralis minor, assisted by the pectoralis major and latissimus dorsi. The sternal fragment is displaced by the action of the sterno-cleido-mastoid muscle, although the fixed position of this extremity through the attachment of the rhomboid ligament and subclavian muscle limits very materially the degree of displacements. Prof. Agnew has directed attention to the action of the rhomboideus major and minor, which, in fracture of the bone, rotate the acromial fragment, and thus change its position in its relation with the sternal fragment, from an anterior to that of one under or posterior. The displacement of the extremity is therefore *downward*, *forward*, *inward*, with a rotation of the acromial fragment on its axis.

The displacement can be overcome, and the fragments retained in apposition by carrying the shoulder *upward*, *outward*, and *backward*, and the dressings should be so applied as to accomplish this object, and at the same time keep the inferior angle of the scapula *forward.*

Application of Dressings in the Recumbent Position.—According to this method of treatment, the patient is placed in bed upon a firm mattress, with the head resting upon a low pillow, and the chin slightly depressed. The arm of the affected side is flexed so that the hand can grasp the point of the opposite shoulder (Velpeau's position). In this position it will be found on examination that the displacement is overcome, and that the fragments are in apposition. A spiral roller applied around the chest, the turns beginning below and carried upward, will assist the patient in maintaining this position of the arm. If the patient objects to the confinement in bed for the full length of time required for union of the fracture (from four to six weeks), he may remain for the first week or two, until the reparative process has made sufficient progress to hold the fragments in apposition under any of the forms of dressings employed in the erect position. Treatment in the recumbent position, providing the full coöperation of the patient is obtained, affords better results than can be secured by any other method.

Application of Dressings in the Erect Position.—The object of the dressings applied in this position is not only to overcome the displacement, and maintain the fragments in apposition, but to permit the patient to walk about and engage, to a certain extent, in his business pursuits. Of the dressings devised for use according to this method, there are a large number, consisting of bandages applied in va-

rious ways, with and without pads in the axillæ, slings, pads, and rings, adhesive plaster, and plaster of Paris dressings.

Bandage Dressings.—These consist of the posterior figure-of-eight (Fig. 49), Desault's and Velpeau's bandages. Of these the posterior figure-of-eight was first employed. Its use has been largely discontinued on account of the difficulty experienced in preventing pain by pressure of the turns of the bandage in the axillæ and the production of excoriations, if the bandage is applied with sufficient firmness to accomplish the purpose of straightening the clavicle. Modifications of this form have been made in leather and cloth, the shoulder-straps, made of chamois skin or some soft material, being stuffed and fastened to back pieces; the arm is, in this form, suspended in a sling. Dr. E. M. Moore, of Rochester, N. Y., has devised a modification of the posterior figure-of-eight bandage, which, by enveloping the elbow at the arm of the affected side, assists in throwing the shoulder outward, and at the same time, obtaining elevation of the arm. If bandages of this form are used care should be taken to protect the surfaces of the shoulders and axillæ from compression.

Desault's Apparatus.—As already described (p. 100, Fig. 67), this apparatus consists of three bandages and a pad; the first bandage can be dispensed with by using tapes to hold the pad in place, and this will contribute to the comfort of the patient by the removal of one covering, an important consideration in warm weather. This form of dressing fulfils the indications present in the treatment of fracture of the clavicle, but is liable to become disarranged by the movements of the patient. This can be obviated to some extent by stitching the turns together, or covering the outside with a layer of starch or plaster.

Velpeau's Bandage.—The position in which the arm is placed in the application of this bandage secures an excellent adjustment of the fragments, and the turns of the roller increase the advantages gained by the position by affording complete support. In the use of the bandage care should be taken to prevent excoriation of the surface of the chest and inner surface of the arm by the intervention of soft compresses (Fig. 66).

Fox's Apparatus.—In 1828, Dr. George Fox, of Philadelphia, devised an apparatus for treatment of fracture of clavicle, which consists of a sling, a pad, and a ring. To the sling tapes are sewed, which secure it to the ring which is applied over the shoulder of the sound side; the pad is placed in the axilla of the affected side, and is held by tapes

Fig. 107.

which attach it to the ring. This dressing has been employed, since its introduction, in the surgical wards of the Pennsylvania Hospital with the most successful results, espe-

cially in fractures of the outer extremity of the bone (Figs. 107, 108).

Fig. 108.

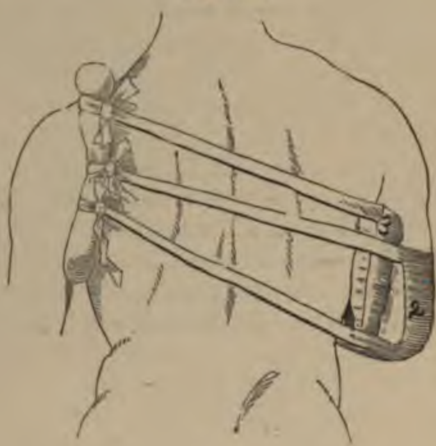


Fig. 109.

Modifications of this form of dressing have been made by Hamilton, Levis (Fig. 109), and others.

An efficient dressing, according to the experience of Prof. Agnew, may be made from a piece of strong muslin, two yards long and seven inches wide, prepared as the four-tailed sling, with the body twelve

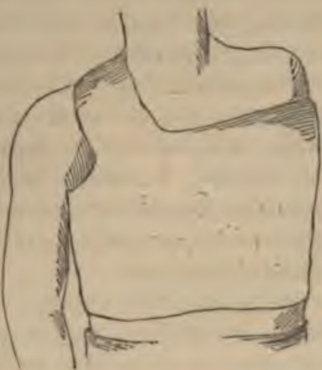
inches in length, and in the centre of this an opening to receive the point of the elbow. The arm being placed so that the hand grasps the opposite shoulder, the point of the elbow is placed in the opening; the lower tails are passed over the chest anteriorly and posteriorly and tied together over the sound shoulder; the tail carried across in front of the chest should pass beneath the arm. The upper tails are passed around the arm and body, and tied on the opposite side.

Adhesive Plaster Dressing.—Dr. Sayre, of New York, secures the arm in position by means of two bands of adhesive plaster, three inches and a half in width, and of such length as may be required. One band is applied about the arm of the affected side, and then drawn across the back, and made to encircle the body (Fig. 110); the second band receives the point of the elbow in an opening provided for that purpose,

Fig. 110.

Plaster of Paris Dressings.—In the Bellevue Hospital, New York, a plaster dressing has been introduced which is described as being both efficient and comfortable. The arm is placed in the Velpeau position, and secured by alternate turns of the roller around the chest and over the forearm and hand. The plaster is applied over the turns as in the ordinary plaster bandage (Fig. 113).

Fig. 113.



In the description of the different dressings which are employed in the treatment of fracture of the clavicle it will be observed that they are of three general forms. One class of the dressings is so applied as to act on the shoulder, another upon the elbow, while a third combines action upon both shoulder and elbow. Authorities agree that, under any form of dressing, union without more or less deformity, with accompanying shortening, is of rare occurrence. Efforts should always be made to secure the best results.

SCAPULA. *Causes.*—Fracture of the body is the result of force directly applied. The processes, head, and possibly the neck, may sustain fracture by indirect violence transmitted through the arm. A case is reported in which fracture of the neck occurred as the result of muscular contraction, in the effort made by a lady to throw a necklace over the head.

Symptoms.—The symptoms vary according to the position of the fracture. Pain on movement, with more or less loss of function of the arm, is usually present. Deformity accompanies fracture of the more superficial portions of the bone. Crepitus can also be detected.

Diagnosis.—In fracture of those parts of the bone which can be grasped by the hand crepitus may be elicited and deformity recognized. In fracture of the neck or processes, crepitus may sometimes be felt by grasping the parts and executing movements of the arm in various directions.

Prognosis.—Slight impairment of function of the arm may follow fracture of the scapula when accompanied by severe injury of the soft parts, or when the result of gun-shot wounds. Union with more or less displacement of the fragments occurs in simple fractures of the body. Fibrous union occurs, as a rule, after fractures of the acromion or coronoid processes.

Treatment.—The character of the dressings applied in fracture of this bone depends upon the seat of the fracture, whether it be in the body, neck, acromion, or coracoid processes.

Body.—In fractures of the body the fragments may be kept in apposition by the application of a broad band of adhesive plaster carried from the vertebral column across the broken bone, being well moulded to its anterior and posterior borders, and terminating within three to four inches of the sternum. The ends of the band should be fastened after it has been well adjusted over the scapula. The arm should be flexed and placed in the sling of Fox's apparatus, the elbow elevated by fastening the posterior tapes to the ring on the opposite shoulder, and the arm held against the body by the turns of the spiral bandage.

Neck, Acromion, and Coracoid Processes.—In fracture of these parts of the bone the head of the humerus should be pushed up so as to act as a support, and it should be held in this position by Velpeau's bandage. Fractures of acromion process may be treated by confining the patient in bed, and carrying the arm directly away from the body, and supporting it upon a pillow. The function of the shoulder-joint is liable to become impaired by the disuse to which it is subjected in the treatment, as well as its involvement in fractures of the neck and glenoid cavity, and it is therefore important that passive motion should be instituted at the end of the fourth week.

HUMERUS.—Fractures of this bone may occur in the upper extremity, the shaft, and the lower extremity. Those of the upper extremity are divided into fractures within the capsule (intra-capsular) and those without (extra-capsular).

INTRA-CAPSULAR FRACTURES. *Causes.*—Fractures within the capsule are generally the result of gunshot injuries, producing those which are compound in character. Direct violence, as in a railroad crush, may cause a comminuted fracture of the head of the bone, or fracture through the anatomical neck.

Symptoms.—In compound fractures the symptoms are sufficiently plain, whilst in simple fractures they may be very obscure. Pain, with loss of function, is usually present; crepitus is not well marked, and deformity is absent, except in cases of impaction, in which there may be flattening of the shoulder, with projection of the acromion process.

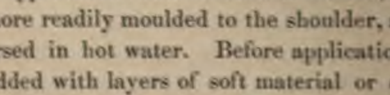
Diagnosis.—In compound fractures the joints can be explored with the finger, and the fracture detected. In some cases of simple fracture the head of the bone may be seized and crepitus elicited by rotating the shaft. Impacted frac

tures may be recognized by pressing the finger into the joint from the axilla, and in this way detecting the shortened head.

Prognosis.—Osseous union does not occur after intra-capsular fracture. When fragments are detached in compound fractures, necrosis and suppuration may ensue, and they may be discharged. Fibrous union may follow incomplete separation through the anatomical neck. When the separation is complete the head of the bone loses its vitality and disappears by a process of absorption. The late Prof. Gross records a case in his System of Surgery in which the "head of the bone, united by a thick layer of osseous matter, is turned upside down."

Treatment.—In intra-capsular fractures the dressings should consist of a shoulder-cap extending to within three inches above the elbow, and a broad roller which secures the arm to the side of the body. The arm should be flexed, and the hand drawn across the chest and supported in a sling. The shoulder-cap can be found in the shops, made of felt or other substance (Fig. 114). An excellent substitute can be made

Fig. 114.



from a piece of binder's board of suitable width and length, the edges of the upper end of which should be incised, in order that it may be more readily moulded to the shoulder, after having been immersed in hot water. Before application it should be well padded with layers of soft material or cotton-wool. Fracture through the anatomical neck is best treated by

the introduction of a small, wedge-shaped pad in the axilla with the shoulder-cap, and the application of Velpeau's bandage, so as to support the shaft against the head of the bone, and secure the dressings in position.

Extra-capsular Fractures.—In this class may be included fractures occurring between the anatomical neck and insertion of the latissimus dorsi and teres major muscle.

Causes.—The causes concerned in their production are external violence directly applied, the arm being held near the body, and resulting in fracture of the great tuberosity, through the epiphysis, or surgical neck.

Symptoms.—The symptoms vary with the nature of the fracture. In all, pain and impaired function are more or less distinctly marked. In fracture of the great tuberosity and through the epiphysis the shape of the shoulder is altered, increased in breadth, with undue prominence of acromion process in the former; in the latter, the rotundity of the shoulder is not removed, but a prominence due to the upper end of the lower fragment exists just above the coracoid process. In fractures through the surgical neck the usual signs of fracture are present—pain, loss of function, shortening, preternatural mobility, and crepitus.

Diagnosis.—As a rule, the detection of fractures in this region is difficult, owing to the absence, in some, of the marked symptoms of fracture; and in others, to the obscurity which attends them by reason of the swelling which is liable to occur soon after the receipt of the injury. The differentiation between fractures occurring at this point and dislocation at the shoulder-joint is always to be considered. Crepitus is indistinct, and difficult to elicit in fractures through the epiphysis and greater tuberosity—more easily obtained in fractures of the surgical neck. As a rule, the displacement

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of the fragments is not very great, unless the injury has followed the application of great force. The diagnosis is still more difficult if impaction has occurred. Its presence may be suspected if the arm is shortened and its function impaired with the absence of the marked signs of luxation. Extensive manipulation should not be resorted to in these cases, lest the impaction may be disturbed.

Prognosis.—Favorable as to union in all, with but slight, if any, impairment of function; fibrous union is liable to occur after fracture of the great tuberosity, owing to the difficulty of securing and maintaining accurate approximation of the fragments.

Treatment.—In all extra-capsular fractures, including those of the great tuberosity, separation of the epiphysis alone, or with the head and tuberosities, and those of the surgical neck, the best form of dressing consists in the application of the shoulder-cap, which should envelop the outer, anterior, and posterior surfaces of the arm, and extend below to a point above the condyles, with a short internal splint; or, as Prof. Agnew prefers, the internal angular splint reaching to the end of the fingers. He also advises the use of the primary roller, which should extend from the hand to the shoulder. The internal angular splint is carefully padded and placed on the inside of the arm, the upper extremity being covered by a mass of cotton-wool, and carried well up into the axilla. The shoulder-cap—lined with cotton-wool or a soft compress, turning over the upper and lower edges, so as to remove pressure at these points—is placed in position, and a second roller is applied over both splints, beginning at the hand and terminating at the shoulder, by a few turns of the spica bandage of the shoulder. The hand and wrist are supported in a sling, and the arm is confined to the side of the body by

spiral turns of a roller, or a single strip of muslin may be employed in its place, with the advantage of greater comfort to the patient (Fig. 115). The internal angular splint may

Fig. 115.

be dispensed with in the treatment of these fractures, the side of the body affording, when the arm is flexed and held against it by turns of the roller, sufficient support to prevent displacement.

Compound fractures of the upper extremity should be dressed in the same manner as those which are simple, precautions being taken to provide a free escape for inflammatory products, should they form. In compound and comminuted fractures involving the shoulder-joint the expediency of practising excision should always be considered.

SHAFT. *Causes.*—Force applied directly is the cause of most fractures occurring in the shaft of this bone. Many

instances are recorded in which muscular contraction has produced fracture. In some of these but slight effort had been made.

Symptoms.—The symptoms are usually well marked, and are those of fractures in general.

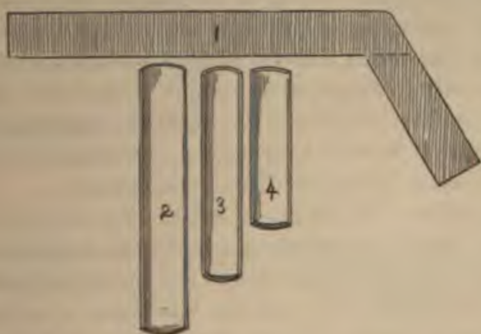
Diagnosis.—Owing to the marked character of the symptoms the diagnosis is not difficult. Deformity, preternatural mobility, and crepitus are present, and can be recognized. The direction of the displacement of the fragments depends upon the relation which the seat of fracture has to the muscular attachments. The action of the deltoid muscle is especially marked in the production of displacement when the fracture occurs just above or below its point of insertion. The biceps and triceps muscles exert a decided action on the lower fragment in fracture through the lower third.

Prognosis.—While in simple fractures the prognosis may be stated as always favorable, yet there are frequently conditions which arise in connection with fractures of the shaft which complicate the results in a marked degree. Among these may be enumerated deformity, stiffness of the elbow-joint, false-joint, paralysis of the extensor and supinator muscles of the forearm, owing to injury inflicted upon the musculo-spiral nerve, and finally extensive sloughing, as the result of compression of the brachial artery by the fragments.

Treatment.—Adjustment of the fragments having been obtained by extension, counter-extension, and manipulation, a roller is carried from the hand to the shoulder, and an internal angular splint, having an obtuse angle, and of sufficient length to extend from the axilla to the ends of the fingers, is applied to the inner surface of the arm, which is flexed at the proper angle, and the shoulder-cap is placed in position. A second roller is now applied, extending from the hand to the shoulder, terminat-

ing in the spica bandage of shoulder, fixing the splints firmly in position. In place of the shoulder-cap splint three short splints may be substituted (Fig. 116); the longest one is applied to the outer surface, the next in length to the pos-

Fig. 116.



terior, and the shortest to the anterior surface. The arm is to be suspended in a sling.

LOWER EXTREMITY.—Fractures of the lower extremity embrace those above the condyles, *supra-condyloid* and those of the condyles, *condyloid.*

SUPRA-CONDYLOID FRACTURES. *Cause.*—Force applied directly to the lower extremity of the bone or transmitted by falls upon the hand.

Symptoms.—The symptoms are usually well marked in fracture at this point—deformity with shortening, unnatural mobility, and crepitus. The deformity is produced by the overlapping of the fragments, the lower end of the upper fragment projecting anteriorly, just above the bend of the elbow. The mobility is much exaggerated, and not limited

to the normal hinge-joint movement—flexion and extension. Crepitus can be felt by grasping the parts firmly.

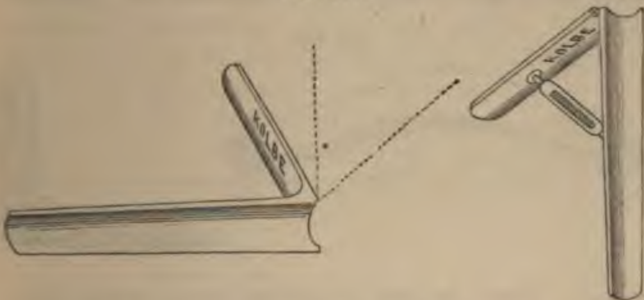
Diagnosis.—The diagnosis is to be made between fracture at this point and luxation of the elbow-joint. The principal signs of fracture are the shortening of the arm, the position of the olecranon process and condyles in the same line, the presence of crepitus, the great mobility of the forearm, and the ease with which reduction is effected and the recurrence of the displacement, if means of retention are not employed. In luxation the length of the arm is normal, the olecranon process is above the line of the condyles, crepitus is absent, the forearm is fixed in its abnormal position, and reduction, which is more difficult to effect, is permanent.

Prognosis.—The prognosis is favorable as to the occurrence of union, but unfavorable in a large majority of cases as to the complete restoration of the function of the elbow-joint. In adults, it is possible sometimes to secure their co-operation in the persistent efforts which must be made to overcome the stiffening, and in some cases firm anchylosis of the joint. In children, however, who do not appreciate the value of the full function of the joint, the task is very difficult, and in most cases impossible to be performed. Efforts should be always made under the influence of an anæsthetic agent to break up the adhesions which may exist, and to exercise the joint, in the hopes of obtaining their removal by absorption, and at least a partial restoration of the functions of the joint.

Treatment.—The dressings in these fractures consist of two rollers, two splints, anterior (Fig. 117), and a posterior angular splint, and a sling to suspend the arm. The best form of the anterior angular splint is that which has a joint which can easily change the angle without disturbing the

dressings, and the screw of which does not interfere with the application of the roller. That devised by Prof. Agnew is

Fig. 117.



moved by a racket-hinge, which accomplishes the object in an excellent manner (Fig. 118). The posterior splint is

Fig. 118.

arranged in the shape of a trough. It may be made of binders' board, leather, or any other material which can be moulded easily to the part, and should extend from the middle of the arm to the middle of the forearm (Fig. 119), and should be deep enough to encircle one-half of the circumference of the arm. The late Prof. Gross employed a trough made of tin. Reduction having been effected, the primary

roller is applied, as in fracture of the shaft, and the anterior splint, extending from the shoulder to the hand, is well padded and placed over the anterior surface, while the posterior splint, also well padded, is applied to the posterior

Fig. 119.

surface. These are held in position by the second roller, which is now applied, and the hand suspended in the sling. Passive motion should be carefully instituted, at the end of the second week, in order to overcome any tendency to anchylosis which might arise, and should be continued at such intervals as may be deemed necessary.

Condyloid Fractures.—These include those through the base—between the condyles—through the base and between the condyles, a combination of the two—of either external or internal condyle and separation of the epicondyle from internal condyle.

Causes.—Fractures of this part of the lower extremity of the humerus are, as a rule, the result of external violence, as blows or falls upon the point of the elbow, the arm being flexed. Indirect force transmitted through the forearm by falls on the hand may be an exciting cause. Muscular contraction has been observed to be a cause in epicondyloid separations, especially in young subjects.

Symptoms.—Pain on movement of the joint; rapid swelling; marked increase in breadth of the elbow; deformity

more or less prominent according to the seat of fracture; preternatural mobility; dislocation of the bones of the fore-arm in certain forms; crepitus more or less distinct.

Diagnosis.—Fractures involving the condyles are to be diagnosticated mainly by the disturbed relations of these prominences to the fixed points of the surrounding structures, and to each other. They are also to be distinguished from dislocation by differentiating the symptoms of each condition.

Prognosis.—In all fractures of the lower extremity, whether directly or indirectly involving the elbow-joint, the prognosis as to the future function of the joint is unfavorable, as anchylosis, with more or less stiffening, is certain to supervene. These conditions may be partially overcome by appropriate and long-continued treatment.

Treatment.—When it is possible for the surgeon to keep the patient under strict observation it would be proper to institute treatment for the purpose of allaying the inflammatory conditions which, as a rule, attend fractures of this region. This treatment should consist in the application of leeches, or the use of sorbefacient lotions, as laudanum and lead-water. During this preliminary treatment, all splints and other permanent fracture dressings may be omitted, the arm being supported on a pillow. It is regarded safer, however, to reduce the fracture, and at once apply the dressings, the lotions being applied if necessary over them. The primary roller should be applied to the arm in a flexed position, and the anterior angular splint, arranged at an obtuse angle, should be placed in position, a pledget of cotton-wool being interposed between the inner surface of the joint and the splint. A second roller is now applied to retain the splint in position. If there exists a tendency to posterior displacement of the fragments and bones involved,

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it is desirable to apply the posterior angular splint or trough as in supra-condyloid fractures (Fig. 120). Passive motion should be commenced, as soon as the inflammation subsides, by changing the angle of the anterior splint. More decided

Fig. 120.

movement should be practised at the end of the second week, and this is best accomplished after the removal of the dressings; this being done, the elbow should be grasped, the point resting in the palm of the hand, and the thumb and fingers embracing and supporting the condyles, while extension and flexion are cautiously made. This manipulation must be per-

formed every second or third day until the expiration of the fourth week, when all dressing may be removed and the arm supported in a sling. The patient should be instructed to practise daily the various movements of flexion, extension, supination, and pronation, and continue the exercise until the function of the joint is restored.

When fibrous adhesions form, as the result of the inflammatory complication, producing anchylosis, the patient should be placed under the influence of an anæsthetic agent and the bands broken by forcible extension and flexion, and motion should be accomplished by repeating this manipulation as may be deemed advisable. If the anchylosis is bony in character, or due to osseous union of a displaced fragment, the question of refracture and non-interference is to be considered. If in the progress of a case anchylosis is found to be inevitable, the arm should be placed at such angle as to permit access to the mouth, and should be allowed to remain in this position.

Compound and comminuted fractures of the elbow-joints are the result of injuries received in machinery or crushing under the wheels of a wagon or car. They are recognized by careful inspection and manipulation; the index finger, after being washed in an antiseptic solution, may be introduced for the purpose of exploring the wound. The prognosis is always of an unfavorable character, the joint, if preserved, being deprived, to a greater or less extent, of its function. In some cases excision or amputation may be demanded. An effort should always be made to save the limb if possible. If by the employment of such local applications as will overcome the inflammatory conditions, amputation is required, it may be performed at a later period if necessary after suppurative action has been established.

FOREARM.—The bones of the forearm—radius and ulna—may sustain fracture conjointly or separately. The seat of fracture of both bones is most frequently at or a short distance below the middle. Of the separate bones, the radius is fractured more frequently than the ulna, and in the lower third more frequently than in the upper third or middle. Fracture of the radius may occur in the neck, below the tuberosity, in the middle of the shaft, or in the lower extremity. Those of the lower extremity present a number of varieties: the line of separation may be one which is transverse, and situated from one inch to one inch and a half above the articulating surface, and may be accompanied by a fracture of the styloid process of the ulna. A second variety is that in which the fracture involves the joint, the styloid process being detached by an oblique line of separation. A third variety, that which is known in this country as Rhea Barton's fracture, consists in a fracture of the posterior portion of the articulating surface, the line of fracture being obliquely upward, and terminating three-quarters of an inch above. Modifications of this form may occur in which the portion of bone separated from the posterior surface is comminuted, and may be accompanied by a transverse fracture of the bone. Fractures of the ulna occur through the olecranon and coronoid processes, upper and lower third, and in the middle; that through the olecranon process is most frequent; fracture of the coronoid process is rare.

Causes.—Fractures of the bones of the forearm may be the result of force applied directly or indirectly, or of muscular contraction. That of both bones or of either bone at the middle is caused usually by force directly applied, as the passage of a wagon-wheel or a blow from a bludgeon. Fracture of the olecranon process of the ulna follows the applica-

tion of sufficient force directly over the parts, as happens in falls upon the elbow, the arm being flexed. Fracture of the lower end of the radius is caused by falls upon the hand, either in a state of extension or flexion—most frequently in the first—the force being applied indirectly, and transmitted through the carpus to the end of the bone. I have met with two instances in which a bilateral fracture (Barton's variety) occurred in elderly females: in one the cause was a fall upon the pavement with both bones extended in the effort to prevent the fall; the other in a lady eighty years of age, and was the result of a fall down a flight of stairs; in this case there was associated with the fracture of the left radius a comminution of the end of the ulna.

Fracture of both Bones. *Symptoms.*—The symptoms are usually well marked: pain is felt on movement, and crepitus can be readily elicited; preternatural mobility with deformity is also present. In some instances the deformity is not very great, while in those of the green-stick variety, occurring in children, it is most marked, and extremely difficult to overcome.

Diagnosis.—The diagnosis in fractures of the bones is not difficult, owing to the well-marked character of the symptoms. In fractures at the lower extremity the deformity may resemble that which is present in luxation at the wrist-joint. The existence of crepitus will establish the nature of the injury.

Prognosis.—More or less impairment of the functions of supination and pronation is liable to occur in these fractures, owing to the encroachments upon the interosseous space by redundant callus or the approximation of the ends of the fragments. As a rule, union takes place readily.

Treatment.—In the treatment of fracture of both bones of

the forearm it is of the utmost importance that the limb should be placed in such position as to preserve the interosseous space and parallelism of the bones. When the fracture occurs in the upper third these conditions are best maintained by applying the dressings with the forearm in the supine position; for fractures in the middle or lower third, the position should be that midway between supination and pronation, the thumb directed upwards. It is also important that the dressings should be applied with the arm in the *flexed* position in order to avoid undue pressure upon the brachial artery at the bend of the elbow, as is liable to occur if they are applied when the arm is extended and afterwards flexed for support in the sling.

Adjustment of the fragments is accomplished by extension and counter-extension with manipulation. Owing to the danger of exerting too much pressure with the turns of the primary roller, and in this way causing encroachment upon the interosseous space, it should be omitted. Two light board splints, one inch wider than the forearm, and long enough to extend from the ends of the fingers to the bend of the elbow, should be well padded, especially at the extremities, and placed on the anterior and posterior surfaces of the limb, and secured in position by the spiral reverse bandage, carried to a short distance above the elbow. Care should be taken to adjust the splints, so that the sides extend beyond the surface of the limb both *below* and *above*, and thus avoid pressure upon the parts. Additional security against pressure by the ends of the splints can be obtained by placing masses of cotton-wool beneath them. The sling in which the forearm is placed should extend from the elbow to the wrist, so as to afford support to the *entire forearm* (Fig. 121). Inspection of the parts should be made daily for the first

week, in order to guard against the dangers of undue pressure, and the dressings should be removed and re-applied if excessive swelling is present, or there are present any symptoms of interference with the circulation. Where comminu-

Fig. 121.

tion of either bone has occurred it is desirable to place a pad between the bones over the interosseous space to maintain this space.

UPPER EXTREMITY OF THE RADIUS—NECK. *Symptoms.*—In fracture of the bone at this point, which occurs very rarely, the symptoms are obscure. If the head of the bone can be grasped and held in a fixed position, while supination and pronation are performed, crepitus may be elicited.

Pain on rotation of the bone will be experienced, mobility is not affected, and deformity is not marked.

Diagnosis.—Owing to the absence of very positive symptoms the diagnosis is difficult. Care is to be taken to distinguish it from anterior dislocation of the head of the bone.

Prognosis.—The proximity of the seat of fracture to the elbow-joint renders this joint liable to the invasion of inflammation and consequent anchylosis, unless means are taken to overcome it.

Treatment.—The forearm is to be placed in a state of *supination* and flexed; in this position the anterior or posterior angular splint well padded (Figs. 118 and 119) is to be applied and secured by a bandage. Efforts at breaking up any adhesions which may have formed in the elbow-joint should not be made until union has occurred, which usually takes place by the end of the fifth week, lest separation of the fragments occur with subsequent deformity.

SHAFT OF THE RADIUS—BELOW THE TUBERCLE. *Symptoms.*—Crepitus may be developed and pain produced by rotation of the forearm, the fragments being approximated; deformity and undue mobility are not marked.

Diagnosis.—The separation of the fragments under the influence of the action of the supinator brevis, causing external rotation of the upper fragment and of the pronator radii teres, producing internal rotation of the lower fragment, can be detected on careful examination. The symptoms are also usually so well marked as to assist in making the diagnosis.

Prognosis.—If union should occur in the position of the fragment above described, the function of supination would be destroyed, and the use of the forearm much impaired.

Treatment.—The forearm should be supinated, flexed, and

the posterior angular splint or trough applied as in fracture of the neck of the radius.

MIDDLE OF THE SHAFT. *Symptoms.*—In fracture at this point the symptoms are well defined; the signs of fracture, deformity, preternatural mobility and crepitus, with pain and loss of the power of supination and pronation, are present, and can be readily recognized.

Diagnosis.—The diagnosis is usually not difficult, owing to the well-defined character of the symptoms. The swelling which accompanies the injury may sometimes interfere with a ready recognition of the nature of the fracture. A study of the action of the muscles attached to the bone will explain the displacement which occurs, the upper fragment being raised and rotated inward by the combined action of the biceps and pronator radii teres muscles, while the end of the lower fragment is directed toward the ulna by the action of the supinator longus and pronator quadratus.

Prognosis.—The tendency of the ends of the two fragments to encroach upon the interosseous space results very frequently in obliteration of the space, and their union to the ulna by callus, in this way the function of supination and pronation being entirely destroyed.

Treatment.—The adjustment of the fragments is accomplished by flexing the arm and manipulating the lower fragment, so as to direct the upper end outward. Extreme adduction of the hand will assist in this effort. A narrow compress, extending from the upper margin of the pronator quadratus to a point just below the seat of fracture, should be placed on the anterior and posterior surfaces of the forearm to preserve the interosseous space. The forearm being placed midway between supination and pronation, the thumb directed upward, two well-padded straight splints, extending

from the elbows to the ends of the fingers, and projecting one inch above and below the borders of the limb, should be applied on the anterior and posterior surfaces, and should be held in position by a roller; the arm should be supported in a sling. In some cases it may be advisable to substitute for the anterior straight splint the anterior angular splint, so as to maintain the arm in a flexed position. If difficulty is experienced in keeping the upper end of the lower fragment outward, the lower ends of the straight splints can be rounded off so as to secure the hand in the position of adduction.

LOWER EXTREMITY. *Symptoms.*—In all of the varieties of fracture occurring at this point the symptoms are characteristic and usually well defined. Outside of those of swelling, pain, loss of function, and crepitus, deformity is most distinctive. In extra-articular fractures of the bone in which the line of separation is transverse, the displacement is in the long axis of the bone, with little or no lateral deviation, giving to the part that disfigurement which was designated by Velpeau as the *silver fork* deformity. In this form the lower fragment produces a marked prominence upon the posterior surface of the forearm, while the upper fragment projects anteriorly and to less degree. Abduction of the hand may be marked in this variety if there should exist with the fracture a rupture of the internal lateral ligament, or a fracture of the styloid process of the ulna.

In that variety of fracture involving the joint in which the styloid process is separated by an oblique line of fracture, the abduction of the hand or lateral deviation to the radial side, affords most characteristic deformity, caused by the contraction of the extensor muscles of the thumb, ossis metacarpi pollicis, and primi and secundi internodii pollicis. In that form known as Rhea Barton's there is a prominence

upon the posterior surface of the forearm produced by the displacement upward of the wedge-shaped piece of bone split off from the articular end, with the carpus, forming a subluxation of the radius upon the carpal bones. The lateral displacement is also well defined with a marked projection of the styloid process of the ulna. Usually the upward displacement of the fragment of bone is not great. In a case, however, which came under my care in the surgical wards of St. Mary's Hospital, this city, I found the segment of bone occupying a position three and one-half inches above the line of the articulation. The patient, a lad eighteen years of age, had fallen through a hatchway from a height of four stories, and had sustained a number of fractures: Barton's fracture of the left radius, with a compound fracture of both bones of the right forearm, and of the crest of the left ilium. He made a good recovery from all of the injuries. In all of the varieties of fracture of the lower end of the radius the swelling is usually very marked, and involves the entire surface. It is due to inflammatory effusions implicating the bursæ which exist in connection with the tendons of the flexor and extensor muscles passing from the forearm to the hand across the radio-carpal joint.

Diagnosis.—Fractures involving the lower end of the radius are to be distinguished from luxations of the wrist-joint, and careful examination is required to do this, the difficulties being greater in some instances than in others. In persons of advanced life, in whom the fracture most frequently occurs, the diagnosis is rendered less difficult by reason of the atrophic changes which have taken place in the overlying tissues. Luxations of the wrist-joint are accompanied by deformity which is due to the displacement of the hand in the long axis of the bone, the hand being

either flexed or extended according to the character of the dislocation; lateral deviation, if present, is not so marked as in fracture. The permanent removal of the deformity after efforts at reduction with the absence of crepitus distinguishes luxation from fracture. It is important that the proper manipulation should be made in order to elicit crepitus. Simple rotation of the hand will not accomplish this. It is necessary that the head of the radius should be grasped and held firmly while the movements of supination and pronation are made. In this way the upper fragment remains fixed, and the lower fragment is moved eliciting crepitus. In some cases it may be necessary to grasp the upper and lower fragment near the line of fracture and move one over the other.

Prognosis.—Unless the greatest care is exercised in conducting the treatment of fractures involving the lower end of the radius, more or less deformity with impairment of the functions of the wrist-joint and fingers is liable to follow. In certain cases it is impossible to avoid these conditions, despite the most careful attention, owing to the inflammatory products which are deposited within the sheaths of the adjacent tendons and wrist-joint. Patients should be informed of the results which may occur, and their full coöperation should be required to assist in preventing, as far as possible, their occurrence.

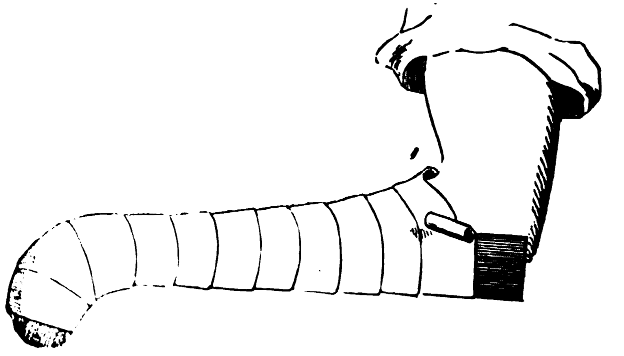
Treatment.—The indications to be met in the treatment of these fractures are: to retain the lower fragment in position after reduction, by compresses, rollers, and splints, and to overcome the deviation to the radial side by so shaping the ends of the splint as to secure marked adduction.

The dressing employed by Dr. Barton consisted in two graduated compresses two and one-half inches square, two

straight wooden splints, the same as used in the treatment ot fracture of both bones of the forearm, and one roller two and one-half inches wide. Reduction is effected by flexing the arm and making extension while the lower fragment is pressed into position by manipulation with the thumb and fingers. In some cases it may be necessary to accompany the manipulation with forcible flexion at the wrist-joint in order to place the lower fragment into apposition. The adjustment of the fragments being maintained by extension and counter-extension, one of the compresses is placed on the anterior surface of the forearm, the base being on a line with the end of the upper fragment, and the apex directed upward; the other compress is placed on the posterior surface, the base on a line with the upper end of the lower fragment, and the apex directed downward. These compresses are now lightly secured in position by a roller beginning around the wrist and then carried to the hand and back to the wrist by figure-of-eight turns and by spiral turns, until the compresses are completely covered. The splints are now placed in position and held by spiral and spiral-reversed turns of the remaining portion of the roller, or it may be consumed in fastening the anterior splint, while a second roller may be used to hold the posterior splint by turns from the hand to the elbow. Care should be taken to apply the roller which secures the compresses in position loosely in order to avoid too much pressure, when the swelling which always occurs is present. For the first week careful *daily* examination should be made of the condition of the parts, and on the third day a renewal of the dressings should be made if no conditions have occurred to demand it earlier. During the remainder of the time required for the completion of union, four to six weeks, redressings should be made

every third or fourth day. As early as the sixth or eighth day gentle motion of the wrist-joint and fingers, including flexion, extension, and rotation, should be instituted and continued at each redressing. These movements should be gradually increased, and after the second or third week the wrist and hand can be soak water, and, after being dried, manipulated and rubb soap liniment. At the expiration of the fifth or sixtl the splints may be dispensed with, and the limb, cove mply with a roller, may be carried in a sling. The m ations of the wrist-joint and fingers should be continue patient being instructed as to those which should be mad rder to restore the functions of the part. This plan or itment, if persevered in faithfully, will remove the rigidity f the articulation which inevitably follows fracture at this point, and enable the patient to regain, to a great degree, if not completely, the function of flexion, extension, supination, and pronation.

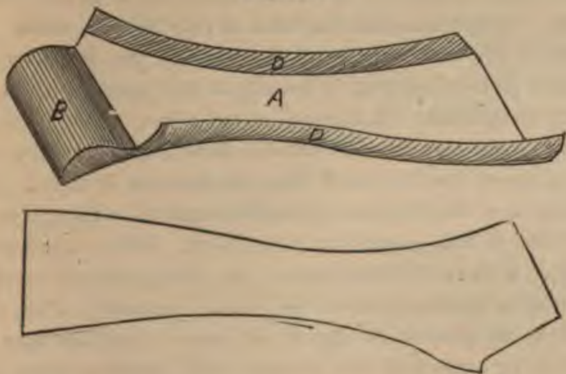
Fig. 122.



In cases of fracture of the styloid process, with or without dislocation of the ulna, in which there is a tendency to

marked adduction of the hand, it is desirable to employ a form of splint which will accomplish adduction and at the same time maintain the fragments in position. For this purpose Nélaton's pistol-shaped splint (Fig. 122), Bond's splint (Fig. 123), that of Coover (Fig. 124), or Levis's may be

Fig. 123.



applied with advantage. Bond's and Coover's splints secure the parts in a natural position, that is, extension of the hand

Fig. 124.

upon the forearm with flexion of the fingers and slight adduction. Graduated compresses with short posterior splints are

severe injury to the joint, adhesions are liable to occur producing anchylosis.

Treatment.—The treatment in fracture of the olecranon process consists in overcoming the action of the triceps muscle, so as to maintain the detached fragment in apposi-

Fig. 125.

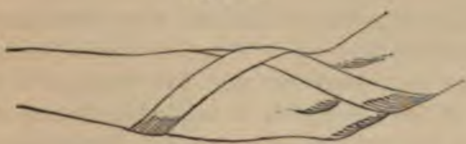


Fig. 126.

tion with the shaft of the bone. To accomplish this purpose the arm must be kept in the extended position after the fragment has been drawn down and secured in contact with the shaft by figure-of-eight turns of a bandage or by one or more strips of adhesive plaster applied in this way. (Fig. 125.) Over this the spiral reverse bandage of the arm should be applied extending to the shoulder, and a splint either straight or with a very slight angle well padded, and reaching from the axilla to the wrist, should be placed on the anterior surface of the arm and secured in position by the turns of a roller. (Fig. 126.) Objection is made to the use of the straight splint on account of the discomfort which attends the maintenance of the arm for a long period of time in a state of full extension.

In cases in which severe injury has been inflicted upon the soft tissues and acute inflammation has supervened, it is necessary that measures should be taken to abate the inflammation by the application of leeches, and after, of sorbefacient lotions, as laudanum and lead-water, the arm being meanwhile placed in an extended position upon a pillow.

When the inflammation has sufficiently subsided the permanent dressings may be applied. Passive motion should be instituted with care at the end of the second week and the parts bathed in warm water and well rubbed with soap liniment. If bony anchylosis is inevitable the arm should be placed in the flexed position, which is that of most service. In a case, which came under my care, of recent union of the fracture with the arm in the straight position in a lad eleven years of age, I succeeded in establishing very good motion in the joint by refracturing the process and permitting union to take place with a separation of the fragments to the extent of one-quarter of an inch. To accomplish this required persevering efforts continued for many weeks, an anæsthetic being administered on each occasion.

Coronoid Process. *Symptoms.*—The extreme rarity of this fracture has prevented extended study of the symptoms. In order to develop any of a marked character a posterior luxation of the joint must be present as one of the most prominent, and fracture of the process may be established by determining the tendency of luxation to recur after efforts at reduction have ceased. The fragment may be felt in front of the joint, to which position it has been carried by movements of the joint and the action of the brachialis anticus muscle partially. If the line of fracture is through the base of the process, the action of the muscle in elevating the fragment will be more marked. Crepitus may be detected

in some cases by placing the arm in a state of extreme flexion and approximating the process to the shaft.

Diagnosis.—Owing to the absence of well-marked symptoms the diagnosis is difficult. Many cases of reported fracture of the process are believed to be based upon incorrect diagnoses, as it seems requisite in most cases to have the condition verified by autopsy.

Prognosis.—The union of the process, after fracture to the shaft, occurs by fibrous tissue. The functions of the part are very little, if any, impaired, although some stiffening of the elbow-joint may result from disuse during treatment, with anchylosis, if inflammation has followed the injury to the joint inflicted at the time of fracture.

Treatment.—The arm being flexed the spiral reverse bandage is applied with careful figure-of-eight turns about the elbow-joint, so as to secure approximation of the detached process, and a posterior right angled splint or trough is fastened to the arm by the turns of a second roller. If it is found necessary to make pressure over the seat of fracture so as to assist in holding the fragment in position, compresses may be applied, and the anterior angular splint employed, care being taken by counter-pressure over the posterior surface of the joint to prevent displacement backward of the ulna and radius.

SHAFT OF THE ULNA. *Symptoms.*—Owing to the fixed position of this bone as compared with that of the radius and the absence of the insertion of any muscles into the middle of the shaft which would conspire to produce to any marked extent displacement after fracture, deformity is frequently absent. In sôme cases it occurs as a result of the fracture-producing force, and the action of the pronator quadratus upon the lower fragment, when the other symptoms of frac-

ture, mobility and crepitus, are also present in marked degree, and are easily detected.

Diagnosis.—The subcutaneous position of the outer border of the bone enables the surgeon to detect the seat of fracture by passing the finger over this border, and crepitus can be elicited by manipulation.

Prognosis.—Unless care is taken to keep the upper end of the lower fragment from encroaching upon the interosseous space union may occur so as to attach the fragments to the border of the radius, and in this way destroy the important movements of supination and pronation. Non-union of the fragments sometimes occurs in patients who are the subjects of some constitutional taint. Immobility of the fragments can be so readily obtained that it would seem to be impossible for it to result from the want of proper adjustment and retention.

Treatment.—The indications for treatment are to secure by manipulation the proper adjustment of the fragments, and by position of the hand and the application of compresses and splints, to so retain them as to preserve the integrity of the interosseous space. The primary roller should be dispensed with in order to avoid pressing the fragments into the interosseous space. The forearm being in a position of semi-pronation, compresses are placed so as to preserve the adjustment which has been effected, and an anterior and posterior splint well padded are applied, extending from the elbow to the ends of the fingers, and are secured by the turns of a roller. A sling, extending from the elbow to the wrist, should be employed to support the arm.

Lower Extremity of the Ulna—Styloid Process. *Symptoms.*—The symptoms most marked in fracture of this process is deformity produced by a displacement of the hand

towards the radial side of the forearm. Pain on movement of the hand, with more or less swelling of the joint, is present. The fragment may be grasped, if the swelling is not too great, and preternatural mobility established.

Diagnosis.—The diagnosis is to be made by careful examination of the parts so as to ascertain the movement of the process under manipulation. Crepitus, if elicited, will be quite indistinct. The roughened surface of the lower end of the upper fragment may be felt if the swelling is not too great.

Prognosis.—The small size of the detached fragment, with the displacement forward of the tendon of the extensor carpi ulnaris, which is placed in a groove behind the process, interferes with an accurate adjustment and retention of the fragments, and results in more or less deformity. Union is by fibrous tissue.

Treatment.—The hand should be carried from the radial side and extended, and an effort made to adjust the fragment by manipulation. Adjustment having been effected, a compress should be placed over the seat of fracture, and a Bond or Coover splint (Figs. 123, 124) applied, and secured in position by the turns of a roller. A sling to support the arm will complete the dressing.

HAND.—Fractures of the hand include those of the carpus, metacarpus, and phalanges.

Causes.—The causes of fracture of the different parts of the hand are, as a rule, direct force, and usually of such nature as to render the injury compound in character—as crushes in machinery and gunshot wounds. The metacarpal bones are frequently fractured by indirect force, as from blows given with the fist, the violence being inflicted upon the distal extremities of the bones.

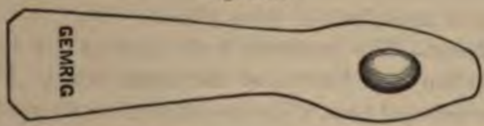
CARPUS. *Symptoms.*—Owing to the arrangement of the carpal bones with regard to the synovial membranes which line the articular surfaces, and the intimate relation of the tendons which cross the carpus anteriorly and posteriorly, any injury which would cause fracture of these bones would be attended by marked swelling. Crepitus might be detected by performing flexion and extension of the hand. Pain, with loss of function, would be present.

Diagnosis.—The detection of crepitus is necessary to establish the existence of fracture, as the other symptoms of pain, swelling, and loss of function accompany equally well contusion or severe strain of the carpal joints. Where extensive comminution of the bones has occurred, crepitus may be detected without much difficulty. In compound fractures of the carpus, the parts can be explored with the probe or finger, and in some instances inspected, and the character of the injury determined.

Prognosis.—In simple fracture of any of the carpal bones, unaccompanied by severe injury to the parts, the prognosis is favorable. Consolidation of the bones may follow extensive involvement of the parts by inflammation and marked impairment of function may occur as a result.

Treatment.—Compresses being placed, if necessary, over the seat of fracture, the hand is extended and placed on an anterior splint, which should extend from the middle of the forearm to the ends of the fingers. On that part of the splint occupied by the palm of the hand, a pad, made of a roller bandage or a mass of oakum, should be placed so as to secure proper extension of the hand, and preserve the concave shape of the palm (Fig. 127). The splint thus prepared should be held in position by a bandage, and the forearm supported in a sling. In compound fractures of the carpal bones the

Fig. 127.



question of excision or amputation is to be carefully considered. Primary amputations should, as a rule, be avoided, in the hope that the reparative process may proceed to a successful termination, with the preservation of a useful member.

METACARPUS. *Symptoms.*—The usual symptoms of fracture are present in fracture of these bones, as pain, deformity, mobility, and crepitus. The deformity varies in accordance with the nature of the fracture-producing force, if it is directly applied, and the line of separation is transverse, the displacement is very slight, if any. Where the force is applied indirectly upon the distal ends of the bones the line of fracture is oblique, and an overlapping of the fragments occurs, causing a projection upon the palmar and dorsal surfaces, and a depression over the metacarpo-phalangeal joint. Mobility and crepitus may be detected by grasping firmly the upper fragment with the thumb and finger of one hand, and the metacarpo-phalangeal articulation with the other hand, and moving the fragments upon each other.

Diagnosis.—The symptoms are usually sufficiently distinct to render the diagnosis easy. The ease with which the parts can be examined and manipulated assists in establishing the diagnosis.

Prognosis.—Union takes place readily, attended very frequently by a deposit of callus, which produces a slight deformity on the dorsal surface. Necrosis of the bone may occur, with involvement of the wrist and metacarpo-

phalangeal articulation by inflammation, resulting in some instances in anchylosis of these joints.

Treatment.—The treatment is the same as that described in connection with fracture of the carpal bones. Fracture of the metacarpal bone of the thumb requires the application of a splint made so as to support both the thumb and palm of the hand, to which they are held by turns of a roller.

PHALANGES. *Symptoms.*—In fractures of the phalanges the symptoms are well marked.

Diagnosis.—Under almost all conditions crepitus can be detected, and the existence of fracture determined without much difficulty.

Prognosis.—In simple fracture union occurs with little or no deformity. As in fracture of the metacarpal bones, necrosis may accompany fracture of a phalanx, and anchylosis of an adjacent articulation may result from inflammatory action.

Treatment.—Simple fracture of the phalanx may be treated by the application of a splint made from a piece of binders' board, which has been soaked in hot water and moulded to the palmar and lateral surfaces of the finger. A second splint of wood, long enough to extend from the wrist to a slight distance beyond the end of the finger, should be applied upon the dorsal surface (Fig. 128). Both splints should be well padded and held in position by turns of a finger bandage, one-half of an inch in width, carried over the hand and terminating at the wrist. In some cases I have held the fragments in position by narrow strips of adhesive plaster applied on the palmar, dorsal, and lateral surfaces. Two strips are required for the purpose, which should be carried over the tip of the finger, the application beginning at the base. A third strip is now applied by spiral turns, begin-

ning at the end of the finger and proceeding to the base, securing the palmar, dorsal, and lateral strips in position. The dressing is completed by placing the hand upon a palmar splint, as in fracture of more than one phalanx. When union

Fig. 128.

has sufficiently progressed, at the end of a week or ten days, the palmar splint may be dispensed with, care being taken to avoid striking the end of the finger, and causing separation of the fragments.

In compound fractures of the fingers, efforts should always be made to obtain repair without sacrificing any of the parts. In a large number of severe injuries of the hand and fingers caused by crushes in machinery, which have come under my care in hospital and private practice, I have invariably refrained from the use of the knife. By means of adhesive plaster and antiseptic dressings I have succeeded in saving fingers which offered very little hope of success in obtaining repair. As has been well stated by the late Professor Gross, "It is here that conservative surgery may often display its highest excellence."

Pelvis.

Fractures of the bones entering into the formation of the pelvis occur as the result usually of great violence, such as crushes between the drawheads of railroad cars, the passage of the wheels of a car or heavily loaded wagon, or falls

from great heights. They may be complicated by grave injury to the important organs contained within the pelvic cavity, as the bladder or rectum, causing rupture of the former and infiltration into the cavity of its contents. Dislocation may be associated with fracture, and necrosis may occur, resulting in the loss of large pieces of bone. Gunshot fractures occur frequently, involving, as a rule, either some of the abdominal or pelvic viscera. Of the different bones of the pelvis, the ilium, by reason of its more exposed position, sustains fracture most frequently.

SACRUM. *Causes.*—The cause of fracture of this bone is great violence applied directly, as a blow upon the part, fall from a height, or passage of the wheel of wagon or car, producing a fracture in the oblique, transverse, or, more rarely, vertical direction.

Symptoms.—In addition to the symptoms attending fractures, there are frequently those indicating involvement of the pelvic viscera and nerves of the sacral plexus, as paralysis of the lower extremities, retention of the urine, and involuntary passage of the feces. Great pain is felt on movement of the body or on attempts at defecation or urination.

Diagnosis.—Inspection of the part will frequently detect displacement of the fragments. Crepitus can be elicited by pressure exerted by the index finger of one hand introduced into the rectum while the other hand is placed over the external surface. Mobility can be detected in the same manner.

Prognosis.—In simple fracture without serious involvement of the contents of the pelvic cavity the prognosis may be regarded as favorable. The violence required to produce fracture of the bone is usually so great as to necessarily

inflict injury upon the structures within the cavity and as a result render the prognosis doubtful.

Treatment.—Efforts should be made carefully to overcome any displacement which may exist by pressure and counter-pressure, by means of the index finger or a strong vesical sound introduced into the rectum, while counter-pressure is made over the external surface. Over the seat of fracture a compress should be placed and held in position by a T-bandage. In cases in which the anterior displacement is so great as to require pressure constantly applied, a rectal bougie of proper length and size can be inserted and retained by means of a bandage. This instrument should be removed every third day and the bowel washed out with warm water before its re-introduction. The patient should rest upon his back on a firm mattress with the extremities flexed and supported on pillows, and, if necessary, the pressure removed from the sacrum by the intervention of an air cushion or well-padded ring. Attention should be given to the condition of the bladder and rectum. If retention of urine exists, the catheter should be introduced four or six times in the twenty-four hours. If rupture of the bladder has occurred in connection with the fracture, a gum catheter should be kept in the organ so as to prevent the escape of urine into the surrounding tissues. The occurrence of inflammation in the organs of the pelvic cavity should be met by the employment of antiphlogistic measures. Constipation of the bowel should be favored during the early stage of the treatment in order to avoid disturbance of the fragments. After that period injections of warm water may be employed from time to time to remove the accumulation of feces.

Coccyx. *Causes.*—Fracture of this bone may occur as the result of violence applied directly over the part, as that

from a kick or fall, or it may be caused by inordinate pressure backward by the head of the child in its escape from the pelvis during parturition.

Symptoms.—Acute pain is experienced on movement, and crepitus may be produced by introducing the finger into the rectum and making pressure, combined with counter-pressure over the external surface with the fingers of the other hand. Preternatural mobility may be detected by the same manipulation. Deformity is not apparent.

Diagnosis.—The existence of fracture can be determined by the introduction of the finger into the rectum. The history of the case will assist in arriving at the diagnosis.

Prognosis.—In many cases the prognosis is unfavorable owing to the difficulty of obtaining union without deformity, and the extremely painful conditions which follow implication of the nerves in relation with the bone. Violent neuralgia—coccygodynia—frequently occurs after fracture, requiring excision of the bone. In two instances I have performed coccygectomy with entire relief from the most distressing sufferings; both operations were performed in females who had sustained fracture of the bone by falls upon the nates.

Treatment.—Adjustment of the fragments should be effected, if displacement exists, by pressure and counter-pressure, the finger being introduced into the rectum to accomplish this successfully and a compress secured by bandage or adhesive strips should be placed over the parts. The patient should be kept perfectly quiet, resting in the recumbent position upon the side. Enemata should be given carefully every other day so as to prevent constipation. If the tendency to anterior displacement is very great an effort should be made to overcome it by the introduction of a rectal bougie as in cases of fracture of the sacrum.

Os Innominatum.

Ilium. *Causes.*—Great violence applied directly over the bone may cause fracture either in the body or crest. Falls from a height, during which the crest of the bone may come in contact with projecting surfaces may detach portions of the rim. Gunshot wounds are also a frequent cause of fracture of this bone.

Symptoms.—Pain is a prominent symptom in fractures of the ilium especially developed on movement. Deformity, with mobility, may be recognized when the crest or one of the anterior processes is detached. In these instances crepitus may also be elicited. In extensive crushes of the bone these symptoms will be more marked, accompanied frequently by those of injury of some of the viscera.

Diagnosis.—Careful examination of the part will enable the surgeon frequently to detect the seat of fracture, and by manipulation elicit crepitus. Often the symptoms are so obscure as to render the diagnosis difficult.

Prognosis.—The prognosis is influenced largely by the character of the injury. In simple fractures it is very favorable, while in compound fractures, or in those in which serious injury has been inflicted upon the abdominal or pelvic viscera, the prognosis is doubtful.

Treatment.—The position of the patient in bed must be that which will secure most effectually adjustment of the fragments. That which the patient usually assumes, as affording most relief from pain, is elevation of the head and shoulders with flexion of the lower extremities upon the abdomen accompanied, in some instances, by an inclination of the body to the affected side. When reduction is effected the fragments should be held in position by a strong, broad

bandage enveloping the pelvis, or adhesive strips, one and a half to two inches in width, may be applied in oblique and circular directions, covering in the entire bone so as to hold the fragments in apposition. Where comminution of the bones has occurred in compound fractures, the detached pieces should be removed, as they are liable to undergo necrosis and interfere with repair. Careful attention is to be given to the condition of the bladder and bowels, the catheter being employed if necessary to empty the former at stated intervals; the latter should be evacuated by enemata in the recumbent position, the bed-pan being used for the purpose.

PUBES. *Causes.*—The causes concerned in the production of fracture of the pubes are similar to those which exist in fracture of the ilium, namely, extreme violence applied directly over the part. Separation at the symphysis is reported to have occurred in a number of instances during the passage of the head of the child through the pelvis in parturition. Violent abduction of the thighs may also produce fracture, force being applied in this manner indirectly. The seat of fracture is most frequently in the rami, the body, except in cases of comminution, usually escaping injury.

Symptoms.—A prominent symptom in fracture of the pubes is the difficulty experienced in maintaining the erect position or in progression; in severe cases an entire inability to stand or walk exists. Deformity is not marked, mobility and crepitus may be distinguished by manipulation; pain accompanies movements or pressure over the parts

Diagnosis.—Manipulation in the form of pressure or counter-pressure will enable the surgeon usually to elicit crepitus and ascertain the point of fracture. In the female the introduction of the finger into the vagina will assist

materially in this manipulation. Mobility and crepitus may be produced in some instances by grasping the tuberosity of the ischium with one hand and the body of the bone with the other and moving the fragments upon each other.

Prognosis.—In simple cases the prognosis is favorable. In cases complicated by comminution of the bones or rupture of the bladder the prognosis is grave, owing to the dangers which may arise from inflammatory action and urinary infiltration.

Treatment.—The treatment of fractures of the pubes so far as relates to the maintenance in apposition of the fragments is similar to that employed in fractures of the ilium. The thighs should be flexed upon the abdomen and a broad bandage should be applied around the pelvis, a compress being placed over the pubes to overcome any displacement which may exist. Prof. Agnew employs in preference adhesive strips four inches in width and long enough to extend two-thirds around the pelvis; to prevent adhesion to the hair covering the pubes a piece of muslin should intervene. The most important point to be considered in the treatment of fracture of the pubes relates to the condition of the bladder. In all cases the catheter should be introduced and should be allowed to remain until the condition of the organ is definitely ascertained. If rupture has occurred the instrument should be kept in position for six to eight days with a view to keep the organ empty during the repair of the wound. If laceration of the urethra has occurred, perineal section should be at once performed in order to prevent urinary infiltration. When infiltration takes place into the scrotum or perineum, free incisions should be made to permit escape of the fluid and prevent sloughing.

ISCHIUM. *Causes.*—Fracture of this bone occurs less frequently than that of the other bones of the pelvis, owing to its protected position. It may be broken in the ramus or tuberosity, the causes being external violence applied directly, as in blows or falls upon the buttocks.

Symptoms.—Inability to stand or walk is the most characteristic symptom of fracture of this bone. It is especially marked in cases in which comminution of the bone has occurred involving the points of origin of the powerful flexor muscles of the thigh. Pain on movement is felt. Mobility and crepitus can be recognized on manipulation. Deformity is, as a rule, absent.

Diagnosis.—The diagnosis is made by careful examination of the parts. Crepitus may be detected by grasping the tuberosity and moving the fragments while in contact. In corpulent individuals the diagnosis is rendered more difficult owing to the mass of overlying soft tissues.

Prognosis.—Injury of the bladder or urethra is liable to occur and complicate fractures of this bone as in those of the pubes.

Treatment.—The apposition of the fragments in this fracture is accomplished by position of the patient, which should be upon the back with the lower extremities flexed and fastened together, and the buttocks supported in an air cushion. Careful attention should be given to the condition of the bladder. If rupture of it or of the urethra has occurred, the treatment should be the same as that directed in fracture of the pubes.

ACETABULUM. *Causes.*—Fractures of this cavity may occur either in the floor or rim, and are produced by violence applied directly over the great trochanter, forcing the head of the femur against the floor, or indirectly, by falls

upon the knees or feet, driving the head against the border with undue force.

Symptoms.—The symptoms of fracture of the acetabulum are very obscure, and owing to the relations existing between the cavity and the head of the femur, difficult to distinguish from those of fractures of the neck and dislocations of this bone. Simple fissures of the floor of the cavity are unattended by any symptoms which would make their recognition possible. Where the head of the femur is driven through the floor of the cavity, crepitus on making movement may be detected. Mobility and deformity are not characteristic. Pain is not distinctive and arises largely from the condition of the soft structures which, in an injury competent to produce this form of fracture, must be extensively contused. In fractures of the rim of the cavity, crepitus is usually present; when displacement has occurred, deformity and mobility are present as in dislocation.

Diagnosis.—The obscurity of the symptoms renders the diagnosis very difficult. In fracture of the rim it is to be made largely by the exclusion of such symptoms as indicate fracture of the neck of the femur. Fracture is to be distinguished from dislocation mainly by the recurrence of the displacement after reduction. In fracture of the floor or of the rim of the acetabulum, crepitus is to be elicited by efforts at extension and relaxation rather than by rotation and flexion, as in fracture of the neck of the femur. In the female, examination, per vaginam, may assist in detecting fracture of the floor of the acetabulum.

Prognosis.—Except in cases in which injury has been inflicted upon the organs of the pelvic cavity the prognosis is favorable. Simple fracture of either the floor or rim of the cavity is not usually attended with danger.

Treatment.—The treatment should be conducted upon the same principle as that of fracture of the femur. Extension and counter-extension with lateral pressure will overcome the tendency to displacement and maintain the parts at rest. To secure extension, weights should be attached to the limb by adhesive strips, with a cord passing over a pulley (Fig. 96). Counter-extension can be accomplished by elevating the foot of the bed, and lateral pressure may be made by a broad band carried around the pelvis, over the great trochanter, or, if preferred, a broad strip of adhesive plaster may be employed. In some cases it may be found advantageous to treat the fracture by position; suspending the limb by application of Smith's anterior splint. Careful attention should be given to the condition of the bladder.

Lower Extremity.

Femur.—Fractures of the femur are divided into those which occur in the upper extremity, shaft, and lower extremity. Those of the upper extremity are sub-divided into the intra-capsular, those within the capsule of the hip-joint, and extra-capsular, those without the insertion of the capsule.

Intra-Capsular Fractures. *Causes.*—In considering the causes of fracture of the neck of the femur it is necessary to examine briefly the changes which occur in this portion of the bone under the influence of age, and the difference in the angle at which the neck joins the shaft in the adult male and female subject. It was formerly believed that as age advanced an increase in the inorganic salts occurred through which the bone became more fragile and thus yielded more readily to fracture. More recent investigations have shown, however, that a change in the structure occurs which causes great disturbance of the nutrition of the neck of the bone,

the cells of the spongy tissue becoming rarefied and filled with fat, the compact layer thinned and the entire neck diminished in size. This change is more liable to occur in females than in males. Moreover, in the adult female the angle at which the neck joins the shaft approaches nearly a right angle, and the weight of the body is thus transmitted more directly upon the neck. It is also occasionally observed in very old persons, and especially in those much debilitated, that the direction of the neck is horizontal, the head sinking below the level of the trochanters and, owing to the decrease in the length of the neck, becoming almost contiguous with the shaft. It can be readily understood that these conditions predispose to the occurrence of fracture, which in a majority of cases takes place as the result of very slight force, such as that caused by a misstep in walking from the curb to the street, or in alighting from a carriage; in some cases a fall upon the knee or trochanter will produce it; in still others the muscular effort exerted in turning in bed is sufficient to accomplish intra-capsular fracture. The line of fracture varies according to the manner in which the force is applied, being oblique or, rarely, transverse;—the separation of the fibres is, as a rule, complete. Impaction of the fragments occurs in a number of cases, the lower fragment being driven into the upper, and by an interlocking of the fibres is held firmly in this position. In some cases the line of fracture extends beyond the insertion of the capsular ligament, forming a mixed variety of fracture, partly intra- and partly extra-capsular in character. Epiphyseal separation may occur in young subjects as the result of violence, but is regarded as of rare occurrence.

Symptoms.—The symptoms which indicate intra-capsular fracture are usually well marked. Loss of function is manifested by the inability of the patient to stand, or in some

cases to exert any movement of the limb. In cases of impaction the loss of function is not very distinct, patients exhibiting great control over the limb. Pain is well marked in most instances, and is increased on movement; it is referred to the position of the joint, and is deep-seated in character. It may extend downward some distance on the inner aspect of the thigh. The deformity varies according to the extent of separation of the fragments; in those cases in which the fracture is the result of force applied directly, the separation of the bony fibres is liable to be more complete than when it is the result of the application of indirect force or of muscular contraction. In the former, shortening is more marked and prompt in its occurrence, while eversion of the foot is pronounced; in the latter the shortening, which is slight at first, gradually increases and eversion of the foot becomes prominent. Cases occur in which the shortening takes place very slowly, extending over a period of weeks and months, being due to a gradual absorption of the neck of the bone. The shortening varies from one-half of an inch to one inch and a half in the ordinary cases. When the capsular ligament is torn the shortening may be greater, reaching to two or more inches.

Cases are recorded in which the position of the foot was that of *inversion* instead of *eversion;* these positions are anomalous, and are explained as being due to a paralysis of the external rotator muscles.

When impaction does not exist, crepitus may be elicited by placing the fragments in apposition and rotating the limb.

Preternatural mobility is difficult of recognition owing to the relation of the fragments to the joint; by careful manipulation, however, exaggerated motion may be detected.

Diagnosis.—The symptoms of intra-capsular fracture are

usually so distinct as to free the diagnosis from great difficulty. The age of the patient and the nature of the exciting cause are to be considered in arriving at a conclusion. These conditions, as has been observed above, exert an influence in determining the character of the injury. In cases of impaction the absence of marked symptoms render the diagnosis very difficult. It is, moreover, very important to avoid extended manipulation in these cases lest the favorable conditions of impaction be disturbed. In any case, violent manipulations should be avoided as they have a tendency to sever periosteal attachments which may exist, and to separate the fragments. The position of the seat of pain, deep in the groin over the inner and upper part of the femur, may be regarded as characteristic. Loss or impairment of function accompanies, to a greater or less extent, various forms of injuries occurring in connection with this region. In intra-capsular fracture it varies in accordance with the nature of the fracture. Deformity, as manifested by shortening of the limb and eversion of the foot, is present, and varies in accordance with the displacement of the fragments. In impacted fractures the deformity is slight, both as regards shortening and eversion of the foot. Crepitus may be elicited by extending and rotating the limb, while the upper fragment is grasped by the hand, or it may be produced by flexing the thigh upon the pelvis and rotating the limb, while extension is made to keep the fragments in apposition. Preternatural mobility can be best exhibited by placing the patient on the abdomen and carrying the limb backward, as practised by Maisonneuve. By this manipulation the limb can be carried much further backward if broken than when no fracture is present, the intact neck of the bone coming in contact with the rim of the acetabulum

and limiting the movement. Comparison of the position of the great trochanters, in fracture of the neck of the femur, will show a difference between that of the sound and injured side; that on the injured side will be much less prominent, and on rotation of the limb will describe a much shorter arc of a circle.

Prognosis.—The fact that intra-capsular fractures occur, as a rule, in elderly subjects renders the prognosis as to the ultimate results unfavorable. The dangers arising from the confinement in bed for a long period of time of persons enfeebled by age are obvious, and should be avoided in any plan of treatment adopted. Where the injury is the result of great violence the effects are very liable to complicate the fracture and to affect the prognosis. In cases of ligamentous union or non-union of the fragments disability to a greater or less extent always follows.

Much discussion, and that apparently which has been profitless, has taken place with regard to the occurrence of bony union after intra-capsular fracture. Non-union may occur, under certain conditions, in any bone after fracture. Certain conditions attend this form of fracture which conduce to non-union. The causes of non-union which are stated are deficient vascularity of the upper fragment, the presence of the synovial fluid and the want of proper coaptation and maintenance in a fixed position of the fragments. In cases in which the fracturing force or the injudicious manipulations of the surgeon have caused wide separation of the fragments, one of the causes above enumerated would become active in preventing bony union. The great mobility of the upper fragment renders it almost an impossibility to secure an accurate adjustment with the lower fragment and its position in the acetabulum inter-

feres with maintaining it in a fixed position. In such instances ligamentous union or non-union occurs simply from the want of full and complete contact of the fractured surfaces, and not on account of a deficient supply of blood or the presence of the synovial fluid. In impacted fractures or in cases in which a fracture has occurred without any displacement of the fragments, bony union does undoubtedly occur if this relation of the fragments is not disturbed, and it occurs in obedience to the laws which control repair in all fractures. In fractures of the patella, bony union takes place when the fragments are accurately adjusted and maintained in perfect contact, notwithstanding a deficient blood supply and the presence of the synovial fluid; ligamentous union occurs in those cases in which perfect adjustment and fixation of the fragments are not accomplished.

The following propositions may be stated with regard to the repair which follows in intra-capsular fractures of the femur.

1. Bony union may occur after intra-capsular fracture of the neck of the femur in those instances in which the broken surfaces are held together in perfect and close contact by the untorn periosteum or by impaction.

2. Bony union may occur in cases in which the line of fracture is partly within and partly without the capsular ligament, since in these cases displacement of the fragments is not likely to be great, the upper fragment is more fixed in position by reason of the attachments of the capsular ligament, and the fragments after adjustment can be more readily retained in position by dressings.

3. In cases in which a separation of the fragments has taken place, ligamentous union or non-union occurs, owing to the great difficulty, in the majority of cases, of adjusting

the fragments in perfect contact, and, by the ordinary methods of treatment, retaining them in such position for a sufficient length of time. In these cases bony union may occur if, by any plan of treatment, perfect coaptation and immobilization of the fragments can be obtained.

Treatment.—Owing to the dangers incident to the long confinement in bed of elderly and enfeebled persons in whom intra-capsular fractures most frequently occur, the treatment has largely been expectant in character. This plan consists in placing the patient in bed with the limb flexed and secured over a double-inclined plane of the ordinary pattern, or over one formed of pillows. After two weeks he is permitted to get up and sit on a high chair, and shortly afterwards allowed to walk with the aid of crutches. In cases treated in this manner ligamentous or non-union occurs, the neck becomes shortened by absorption, and rounded, the surface is covered with a porcelain-like deposit, and plays in a cavity formed by absorption in the head. The weight of the body is supported by the capsular ligament and the obturator externus muscle, both of which become very much thickened.

Impacted fractures treated by the above plan may result favorably, provided too much manipulation is not practised in arriving at a diagnosis, and great care is exercised during ten or twelve weeks after receipt of the injury in the use of the limb in locomotion.

It is desirable in all cases to make an effort to secure bony union, and to accomplish this, treatment of a more positive character should be instituted. Reduction having been effected and extension maintained, a bandage should be applied, beginning at the foot and terminating by a double spica of the groin, with a broad and rather thick

compress placed beneath it over the great trochanter of the broken bone so as to exert lateral pressure. Before the application of the roller the stirrup, made of adhesive plaster, is to be adjusted as represented in Fig. 96. The limb is now to be placed in the straight position, and after the expiration of six to eight hours the weights sufficient to maintain proper coaptation should be attached. The weights may consist of brick, weighing each five pounds, scale weights, bags containing shot or sand, or a bucket of water, the weight of which can be readily increased or diminished by the addition to or removal of the water. Additional support may be afforded by the application of bags of sand to the sides of the limb; the one on the outer surface to extend from the foot to a slight distance beyond the crest of the ilium; the one on the inside to reach the perineum.

Careful attention should be given to the preparation of the bed, and proper provisions should be made for evacuation of the bowels as described on page 129. The general health of the patient should be closely watched, and tonics and nutritious diet given to maintain strength. If the patient's condition remains good the treatment should be continued for a period of three and one-half to four months. If evidences of the decline of the patient's strength or the formation of bed-sores present themselves, treatment in this form should be abandoned and the patient placed upon the sound side in an easy position with the limbs flexed. As soon as the strength will permit, the patient should, after the application of a suitable bandage, leave the bed and recline in an easy chair, and later take exercise on crutches in the open air.

In a very elaborate and exhaustive paper on "Fractures

of the Neck of the Femur," read before the American Surgical Association, and published in the first volume of its Transactions, Dr. N. Senn, of Milwaukee, attributes the bad results which follow after intra-capsular fracture as due more to the insufficiency of the treatment employed than to the anatomico-pathological conditions of the broken bone. He states "that all of the various methods of treatment suggested and practised have failed in securing perfect coaptation and uninterrupted immobilization. In all intra-capsular fractures union is effected by the production of an intermediate callus from the broken surfaces. Nature's splint,

Fig. 129.

the external callus, for well-known anatomical reasons, is always absent, hence the surgeon's splint has a more important and prolonged application than in fractures in other localities."

The time estimated for bony union to take place is from 80 to 100 days, and treatment should be maintained for at least that period. In impacted fracture no attempts should be made to change the position in which the bone has been placed by the accident on account of the danger of loosening the impaction. Permanent fixation should be accomplished by the plaster-of-Paris bandage, which should be applied so as to include the injured limb from the toes upward, the entire pelvis, and the sound limb from the pelvis to the knee. The method by which suspension of the body is effected and extension maintained during the application of this bandage is shown in Figs. 129 and 130. Tin or

Fig. 130.

wooden splints can be incorporated in the plaster dressing to give more support. Great care should be taken to prevent undue pressure on all prominent bony projections by the interposition of compresses. A flannel bandage should be applied next the skin. With this dressing the patient

can leave the bed in a few days, and in a few weeks walk on crutches. Re-dressing should not be made until the expiration of the fifth or sixth week, and not then unless indications are present demanding it.

Fig. 131.

Fig. 132.

In non-impacted fractures, Dr. Senn advises in addition to the plaster bandage, lateral pressure to maintain coaptation by means of a pad to be adjusted by a screw, applied over the trochanter major, through a fenestrum made in the splint (Figs. 131 and 132). In certain favorable cases he further advises direct fixation of the fragments, which is to be accomplished by subcutaneous drilling of the neck of the femur and nailing the fragments together by means of a bone-peg, as has been done in the treatment of ununited fractures. The principles of treatment enunciated by Dr. Senn are, without question, correct, and their application deserves a trial at the hands of surgeons in the treatment of these fractures, which have heretofore been so largely given over to the expectant plan.

Extra-Capsular Fractures.—In extra-capsular fractures the line of separation varies in direction; in some instances it is oblique, following the inter-trochanteric line, and in others transverse to the long axis of the bone, through the upper portion of the trochanter major. In still other instances comminution may occur with more or less impaction of the fragments. The line may extend within the capsule forming a mixed variety partly within and partly without the capsule. Cases of marked impaction occur in which the neck is forced into the upper portion of the shaft between the trochanters.

Causes.—Fractures without the capsule are, as a rule, the result of violence applied directly over the great trochanter; it may occur from force applied indirectly, as falls upon the foot or knee.

Symptoms.—The symptoms of extra-capsular fractures are usually well marked and are the same as those which attend fractures generally. The pain is very severe and superficial

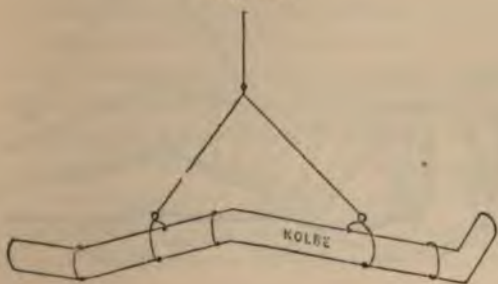
ordinary cases the reparative process takes place promptly and without complications. Bony union occurs as in other parts of the shaft; non-union may occur as the result of excessive inflammatory action, and in some instances enormous masses of callus are deposited about the seat of fracture. More or less disability follows extra-capsular fracture, where great comminution has occurred; this condition is inevitable and is frequently very great. In impacted fractures efforts should *not* be made to correct the deformity which is present, unless it should be so great as to render the limb valueless in its abnormal position.

Treatment.—The treatment of extra-capsular fractures is in general the same as that employed for those occurring within the capsule. The limb should be placed in the straight position and extension made by weights, with bags of sand placed on either side to afford lateral support. Counter-extension should be made by elevating the foot of the bed. If the fracture is impacted weights sufficient only to maintain the limb in the extended position should be applied.

The treatment of this form of fracture may also be conducted by means of the long external, with the short internal wooden splint, which should be well padded so as to avoid undue pressure. The modified Desault's apparatus affords an advantageous dressing of this kind. Junk-bags are placed on the inner surfaces of the splints to relieve pressure. Extension is made by fastening the foot by means of a bandage to the foot-piece attached to the lower end of the external splint, while counter-extension is effected by the perineal band secured to the upper end, or by an adhesive strip attached to an iron rod which extends from the upper end of the long splint over the front of the patient's shoulder

and is held in position by strips of plaster applied around the chest. In the treatment of this fracture suspension of the limb by means of Smith's anterior splints affords a very effective and at the same time a very comfortable form of dressing. The principle upon which the splint is made is that of the double inclined plane, and in using it the adjustment of the fragments is maintained by *position* and not by any efforts at extension. It consists of two parallel rods of wire held together by cross-pieces, and is fashioned in the shape of the double inclined plane. (Fig. 133.) Before application it should be wrapped with a

Fig. 133.



bandage and bent at such angle as to conform to the injured limb. At the ankle and groin where the turned-up extremities come in contact with the surface, thick compresses should be interposed to prevent undue pressure. Adjustment of the fragments having been accomplished, the limb is carefully supported and the splint is applied to the anterior surface and held securely in position by turns of the roller beginning at the toes, and terminating about the pelvis. A coating of starch or solution of the silicate of sodium will fix

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the roller in position. The hooks to which the suspension cord is fastened should be attached above and below so as to afford equable support, the upper one at the junction of the lower with the middle third of the thigh, or over the seat of the fracture if not too high, and the lower at the junction of the middle with the lower third of the leg. (Fig. 134.) The suspension cord should pass through a

Fig. 134.

pulley attached to a crossbar supported by strong uprights. In the treatment of fractures of the lower extremity at any point, suspension of the limb gives great comfort to the patient and permits cautious movements of the body without endangering the adjustment of the fragments, the limb, swinging from the point of its suspension, follows the movements of the body without resistance.

Great Trochanter.—Fracture of the great trochanter, as an independent lesion, occurs very infrequently. The upper portion may be broken off, or it may occur as a separation at the epiphyseal line.

Cause.—Great violence, applied directly over the trochanter, is requisite to detach it from the shaft, such as that sustained in falls, or blows.

Symptoms.—The symptoms resemble to some extent those present in fractures of the neck of the femur. One, which may be regarded as characteristic, is the inability of the patient to sit down, the increase of pain being so great as to compel a discontinuance of the effort. Eversion of the limb is present. Crepitus may be elicited, but it is difficult to accomplish owing to the wide separation of the fragments. Pain and swelling are usually present as the result of the injury to the surrounding parts.

Diagnosis.—The absence of any peculiar symptoms renders the diagnosis, in most cases, difficult. The removal of the prominence formed by the trochanter and the existence of a sulcus or depression in its place is diagnostic. The evidence is more positive when the detached fragment can be grasped and brought in apposition with the shaft so that crepitus may be elicited. This effort may be assisted by strongly abducting the limb and fixing the upper fragment. Shortening of the limb, if present at all, can only exist to a slight degree. Separation at the epiphyseal line may occur in persons under twenty years of age; the trochanter is united to the shaft by bone at or about that time of life.

Prognosis.—The injury inflicted upon the parts at the time of the occurrence of the fracture is sometimes followed by grave constitutional disturbances and later by excessive suppuration. Non-union of the fragments or ligamentous union occurs. Partial ligamentous and partial bony union have been observed in some cases. Disability more or less permanent in character is liable to follow.

Treatment.—Efforts should be made by abduction of the limb, to approximate the fragments and to retain them in apposition by means of compresses and broad bandages or broad strips of adhesive plaster. A broad leather belt, with a hollow pad to apply over the prominence of the hip, as recommended by Sir Astley Cooper, may be applied to accomplish the same result. Immobility of the affected limb should be effected by wooden splints placed on the inside and outside. Extension is not required.

SHAFT.—Fractures of the shaft of the femur may occur either in the upper third, middle, or lower third—the most frequent seat of fracture is the middle of the bone. The line of separation is, as a rule, oblique, and varies in position in different parts, being generally downward and inward in the middle, and downward and forward in the lower third.

Causes.—Violence, applied directly or indirectly, may be the cause of fracture of the shaft. Direct force may be applied by the passage of the wheel of a heavily ladened wagon or car, the crush by the fall of a mass of earth, or a heavy piece of timber. Indirect force may be applied by falls from a height upon the foot or knee. I have now, under my care at St. Mary's Hospital, a lad seventeen years of age, who sustained a very oblique fracture of the femur in the upper third by a fall upon his feet through a hatchway, precipitating him the distance of nearly fifty-feet. Cases are recorded in which fracture of the shaft has been produced by muscular action.

Symptoms.—The symptoms of fracture of the shaft of the femur are well marked, and consist of those which attend fractures generally, as pain, loss of function, preternatural mobility, deformity, and crepitus.

Diagnosis.—The diagnosis is usually made without diffi-

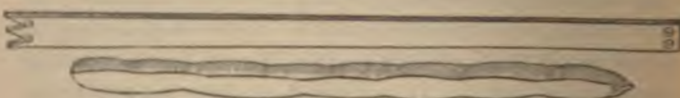
culty, owing to the distinct character of the symptoms. Crepitus can be elicited by rotation of the limb after bringing the fragments into apposition by extension.

Prognosis.—In simple fractures the prognosis is favorable with regard to union. In compound, and especially in compound comminuted fractures, extensive suppuration with necrosis of bone may occur, retarding the reparative process and terminating sometimes in non-union. An excessive deposit of callus may surround the seat of fracture, giving rise to deformity. More or less shortening of the limb is liable to follow in all cases. Especially is this true with regard to fractures in which the line of separation is in the oblique direction. The shortening varies from one-half to three-quarters of an inch—in some cases it is much greater, reaching two inches or more. It is the general opinion of surgeons of experience that it is impossible in some cases to obtain a better result, and a cure of an ordinary oblique fracture of the femur in which the shortening of the limb is from one-half to three-quarters of an inch is regarded as, in every respect, a successful termination. In a strictly transverse fracture, in which the fragments are accurately apposed and retained in such position, very little, if any, shortening should occur; such fractures are, however, of rare occurrence. The shortening which occurs in oblique fractures is to be explained by the action of the powerful muscles of the thigh, which is antagonized by the resistance offered by the large and strong bone whilst intact. It is difficult to adjust accurately the oblique surfaces, more or less irregular, and to completely overcome in the treatment the contraction of the muscles.

Treatment.—Fractures of the shaft of the femur may be treated with the limb in one of two positions—straight or semi-flexed.

Treatment in the Straight Position.—The dressings which have been employed for the purpose of retaining the fragments in apposition during repair have varied very much in form and character from the earliest day to the present time. Those used consisted at first of cumbersome wooden splints applied to the lateral surfaces of the limb. In some forms they were applied to both the sound and injured sides, extending from the feet to the axillæ, inclosing the patient, as it were, in a box. To obviate the great difficulties encountered in securing extension and counter-extension, without producing undue pressure, and in the long axis of the body, modifications were from time to time devised. These related chiefly to the adaptation of foot pieces to obtain extension, and increase in the length of the external splint, or change in the form of the perineal band or upper extremity of the short internal splint, to avoid the pressure exerted over the perineum and to accomplish counter-extension in the long axis of the limb. Anterior splints were employed in some varieties of apparatus to prevent anterior displacement of the fragments. Splint-cloths were used to wrap about the splints, and junk-bags were placed between

Fig. 135.



the splints and surface of the limb to prevent pressure, as in Liston's splint (Figs. 135, 136). The late Prof. Gross employed a fracture-box, extending from the tuberosity of the ischium to a level with the sole of the foot, which rested

against a vertical foot-piece. Attached to each side was a movable splint with a crutch-shaped upper extremity, the one on the outside extended to the axilla, while that on the inside was designed to press against the perineum.

When properly applied the wooden splints formed quite firm supports and maintained the parts at rest, but they were, in many instances, very awkward and unwieldy, liable to produce excoriations by pressure on the perineum and at other points, and to become disarranged easily. To inspect the seat of fracture it was necessary, in some of the various forms, to remove the entire dressing, and thus incur the danger of a disturbance of the fragments.

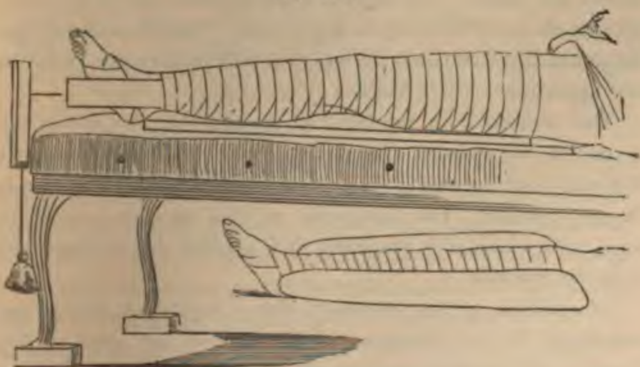
On the introduction of the pulley and weight for the purpose of making extension, and the elevation of the foot of the bed to obtain the counter-extending weight in the body of the patient, a great advance

Fig. 136.

was made in the treatment of fractures of the femur in the straight position. By this plan extension is made in the long axis of the body by means of a stirrup, formed from adhesive strips, which is secured to the limb by circular strips. The strips of adhesive plaster forming the stirrup should extend on the outside and inside of the limb to a point *just below* the seat of fracture, and should be of *equal* length. They should always extend beyond the knee-joint, so as to avoid traction upon this joint. The dressing is prepared and applied in the following manner: The limb having been washed, and, if necessary, deprived of hair, is placed in the extended position, and a strip of adhesive plaster, two and one half inches wide is applied on both sides of the limb so as to extend from a point just below the seat of fracture to the level of the sole of the foot under which the loop of plaster passes. A block of thin wood as wide as the strip of plaster, and from four to five inches long, with a hole in the centre, is placed in the loop of plaster and held by a short strip of plaster ten inches long, with the middle portion four to five inches wide, and the ends two and one-half inches in width (Fig. 93). The middle portion of this short strip is placed on the inner surface of the block, the edges being lapped over, and the ends applied to the inner surface of the long strip extending opposite the position of the malleoli (Fig. 95). This short strip of plaster not only fixes the block in position, but also prevents the plaster from adhering to the malleoli. The extension band is fastened to the limb by three strips of plaster applied in a circular manner, one above the ankle, one below, and one above the knee (Fig. 96). A cord, firmly knotted, is passed through the opening in the centre of the foot piece. Extension and counter-extension being now made, so as to accurately

adjust the fragments, a roller is applied *firmly* but *carefully*, beginning at the foot, and terminating beyond the seat of fracture. Bags of sand are now to be placed on the outside and inside of the limb, that on the outside to extend to the crest of the ilium, and that on the inside to the perineum. The bags should not be too full, as this will prevent moulding them to the inequalities of the surface, and interfere with the accomplishment of equable pressure. After raising the foot of the bed from four to six inches to obtain counter-extension, the limb should remain at rest from six to eight hours until the muscular spasm has measurably subsided, and the plaster extension band has secured firm attachment to the surface; at the expiration of this time the weight, which should be sufficient to maintain the fragments in appo-

Fig. 137.



sition, should be fastened to the cord, passed over the pulley (Fig. 137). The amount of weight required to overcome the muscular contraction will vary in different cases. In a patient of powerful muscular development more weight will

be required than in one of slight muscular power. If it is found at the expiration of two days that the weight is not sufficient to prevent overlapping of the fragments and maintain them in proper apposition more should be added. In the adult male usually ten to fifteen pounds, represented in two or three bricks of five pounds each, are sufficient. The upright support for the pulley may be arranged as shown in Fig. 94, or it may be attached to the foot of the bed (Fig. 137). The latter plan is better, as the support is more fixed and less liable to be displaced. If there exists much tendency to anterior displacement of the upper fragment, a short splint well padded can be placed over the surface beneath the roller. Dr. Gurdon Buck, of New York, surrounded the seat of fracture with four short splints, held together by two leather bands, provided with buckles to fasten them about the limb. The object of this splint was to keep the fragments more securely in apposition. Modifications of the apparatus for extension by weights and pulleys are found in the apparatus of Dr. Morton (Fig. 138).

The treatment of fractures of the shaft of the femur by means of the weights and pulleys, with the lateral support derived from the use of bags of sand, affords the most satisfactory results. The simplicity of the apparatus, and the ease with which it is prepared and applied should commend it to the surgeon.

In addition to the dressings above described, which are employed in the treatment of fractures of the shaft of the thigh in the straight position, is that made by the application of the plaster-of-Paris bandage. The apparatus used for the suspension of the patient during the application of the bandage is shown in Fig. 129, and consists of a table, to which is screwed an upright stanchion with a cross-bar

attached. The nates and lower part of the trunk are supported in a broad sling which is suspended from the cross-bar. The body is brought down so that the perineum rests against the upright stanchion, which is well padded to pre-

Fig. 138.

vent undue pressure, and extension is made by a pulley fastened to the ankle and foot. Reduction having been effected, the limb is incased in a tight-fitting, woollen or flannel covering, and the plaster bandage is applied as directed on page 109. The extension should be maintained until the plaster has hardened so as to preserve the coaptation of the fragments. The patient is placed in bed, where he remains for a few days, and then is permitted to get up and walk on crutches. After the application of the plaster bandage careful attention should be given to the condition of the limb and of the bandage. Examinations should be made frequently to ascertain the state of the circulation of the limb,

as the pressure exerted by the bandage, owing to the swelling, may seriously interfere with it, even to the production of gangrene. On the other hand, the subsidence of the swelling may leave the bandage so loosely applied as to permit displacement of the fragments. The great advantage derived from the use of plaster bandage consists in the release of the patient from confinement in bed.

Treatment in the Semi-flexed Position.—The treatment of fractures of the shaft of the femur in the semi-flexed position is accomplished by means of the double inclined plane or modification of this appliance. The apparatuses of McIntyre, N. R. Smith, and Hodgen are modifications of the double-inclined plane. Fig. 139 exhibits the double-inclined plane

Fig. 139.

combined with the fracture-box. In this method of treatment the muscular contraction is largely overcome by position of the limb. After reduction of the fracture, a roller is applied to the limb, and two splints of binder's board, reaching from the groin to the knee, are applied to the outer and inner surface of the thigh and moulded to the parts. The limb is now placed upon the inclined plane, on which two grooved cushions have been previously fastened and secured in position by turns of a roller. In some instances it is desirable to combine extension by pulleys and weights with the semi-flexed position of the limb over the double inclined

plane as recommended by Prof. Agnew. When this is done the plaster stirrup is attached to the thigh alone. Lateral pressure is effected by raising the sides of the femoral part of the combined plane and fracture-box and securing them in place by turns of a bandage.

In the treatment of fractures of the upper third or in the lower third of the femur above the condyles, the semi-flexed position secures, in many instances, better adjustment of the fragments than can be obtained in the straight position. In compound fractures the position sometimes affords the patient more comfort than when the limb is extended.

Several points demand careful consideration in conducting the treatment of fractures of the shaft of the femur.

1. Great care should be given to the preparation of the bed upon which the patient is compelled to rest for a period of time.

2. Careful inspection of the seat of fracture should be made from time to time in order to ascertain the position of the fragments; if any tendency to displacement exists it should be corrected at once by such means as may be necessary; if possible, shortening should be prevented; if not preventable it should be reduced to the minimum.

3. All parts subjected to pressure by the dressings or otherwise should be frequently examined in order that timely effort may prevent excoriations. Careful attention should be given to the condition of the nates, perineum, if pressure is exerted upon this part, and the heel.

4. If the limb is treated in the straight position, and by extension and counter-extension, the head and shoulders of the patient should be kept low, a small pillow only being used; in some cases even that may be dispensed with.

5. Compound fractures of the shaft of the femur require,

in the treatment, the use of a bracketed splint in order that the wound may be readily exposed without disturbance of the fragments. The long fracture-box containing bran may be employed with advantage, or the immovable dressing, in which a fenestrum has been made, over the site of the wound.

6. In children old enough to comprehend the instructions of the surgeon and attendants the dressings used for adults may be employed. In very young children, or in those difficult to control, the dressings should be made immovable and so arranged as to keep the patient in the recumbent position, in order that the movements of the body may not disturb the fragments. A form of dressing best adapted consists of a long external splint extending from a point near to the axilla to two inches below the sole of the foot. To insure quietude during the application of the dressing an anæsthetic should be administered. The fragments having been adjusted and extension maintained, a roller is applied terminating in the spica of the groin. Projecting bony prominences, as the crest of the ilium, the external condyle of the femur, and the external malleolus, should be protected by masses of cotton-wool, and the splint, well padded, should be placed alongside of the limb and secured in position by turns of the plaster or silicate of sodium bandage. If the latter is used, it is desirable to apply over the seat of fracture strips of binder's board or tin to give additional support, and, at least, three rollers, each being covered with the solution. The upper part of the splint should be secured to the body by spiral turns of a plain roller. The plaster bandage should be covered with a coat of varnish in order to protect it from the effect of the discharges and insure cleanliness by washing the surface. The silicate

bandage is of itself impervious to fluids and can be washed without affecting its firmness.

Instead of the external wooden splint, the late Prof. Gross employed a splint made of stout unoiled sole leather, which was moulded about the limb, beginning around the hip and extending an inch and a half below the foot, at which point a suitable foot-piece was attached. On the anterior surface of the thigh a splint of leather or binder's board, reaching from the groin to the knee, was placed, and after protecting the parts with compresses of cotton-wool, the whole was secured in position by a roller. The foot was fastened to the foot-piece by strips of adhesive plaster. Frequent inspections of the dressings employed in the treatment of fractures of the femur in children are requisite in order that any displacements, which are quite liable to occur in them, may be corrected at once.

7. The time required for union after fracture of the shaft of the femur varies at the different periods of life, and is influenced by the condition of health of the patient and the manner in which the treatment has been conducted. In children consolidation takes place, under favorable circumstances, in three or four weeks. In adults a longer period is required, from five to six weeks. The patient should not be permitted to use the limb in supporting the weight of the body under ten or twelve weeks. Neglect of this precaution may lead to the occurrence of shortening owing to the absence of firmness in the callus which has been formed.

In cases treated by extension the weights should be withdrawn gradually, and the limb enveloped in a firm bandage. On removal of the dressings the patient should rest in bed for a day or two before making an effort to occupy the sitting posture. Locomotion should be accomplished at first with

the aid of c[illegible]tches. In some instances it is desirable to apply the silicate bandage in order to afford more support to the limb.

CONDYLES.—Fractures of the condyles may occur through the base, separating them from the shaft, or one, and in rare instances both, may [illegible] a vertical line of separation. Separation at [illegible] line may occur in persons under twenty years [illegible]

Causes.—Fractures [illegible] condyles are usually the result of great violenc[illegible]irectly, as a fall from a height upon the knee, [illegible] of a horse, or a violent wrench of the limb, the [illegible]g being fixed.

Symptoms.—The swe[illegible]h supervenes rapidly in fractures at this point has [illegible]y to mask the symptoms. Great pain is experienced on any effort at movement, and the function of the limb is lost. With the exception of a marked increase in the width of the knee there is very little deformity. Where displacement of the fragments exists the deformity is more apparent. Shortening is usually not well marked, unless both condyles are broken, when it may occur to the extent of one or two inches. Crepitus can be elicited in most cases by manipulation.

Diagnosis.—As in all cases of fracture near to or involving a large joint, the diagnosis is surrounded with more or less difficulty. On account of the swelling which accompanies the injury very imperfect examinations only can be made. Severe contusions of the joint, especially when associated with dislocation, are accompanied by symptoms which resemble, in some respects, those of fracture of the condyles. If the injury is compound in character, the wound may be explored by the finger, and the nature of the fracture determined. Crepitus is difficult to detect; deep pressure may

enable the surgeon to move the broken fragments. Examinations should be made after the subsidence of the swelling, if any doubt exists as to the nature of the injury. It is a matter of much importance that the diagnosis should be accurately made, in order that the proper plan of treatment should be adopted.

Prognosis.—The danger of involvement of the knee-joint, primarily or secondarily, renders the prognosis unfavorable. When the fracture is through the base of the condyles, the fracture-producing cause is very liable to inflict such injury upon the joint as to involve it seriously. In fracture of one or both condyles the joint is directly implicated, and associated with the fracture, the surgeon must deal with all of the grave conditions which attend inflammation of the structures of a large joint. In compound and complicated fractures the dangers are greatly increased, and the question of amputation presents itself for serious consideration. Under the most favorable conditions more or less swelling and stiffness of the joint are liable to follow, and in complicated cases anchylosis will occur, despite the most skilful treatment. In some rare instances of fracture at the base of the condyles the upper fragment is drawn down behind the lower, and exerts dangerous pressure upon the important blood-vessels occupying the popliteal space. As a result of this pressure, gangrene of the leg and foot may occur.

Treatment.—The preliminary treatment in fractures involving the condyles must be antiphlogistic in character, owing to the inflammatory conditions which almost invariably accompany the injury. The application of leeches and evaporating lotions should be made. Under the influence of an anæsthetic agent reduction should be effected. Sometimes this is best accomplished by flexing the knee and

PATELLA.—In discussing fractures of this bone, it is desirable, in order to comprehend fully the symptoms which attend them, as well as the indications for treatment, to consider its anatomical relations. An examination shows that the common tendon of the group of muscles forming the quadriceps extensor, passing from the anterior and lateral aspects of the thigh, is inserted into the superior and lateral borders of the patella, covering by an expansion of its fibres the anterior surface, and extending to the apex, to the under surface of which it is attached, then is continued as a broad strong band to its insertion in the tuberosity of the tibia, this portion being designated as the ligamentum patellæ. With the exception of the internal surface, which is articular and covered with cartilage. the entire bone is enveloped in the fibres of the tendon, and becomes a part of the tendon as it were. It may be stated, therefore, that the quadriceps muscle is inserted into the tuberosity of the tibia by an osseo-tendinous band, the bone being placed in the tendon for the purpose of affording protection to the knee-joint in front, and to increase the leverage of the extensor muscle. The bone being so much a part of the tendon, it is necessary, in considering fractures of it, to examine into the conditions which take place in the tendon. Fractures of the patella caused by muscular action are always accompanied by rupture more or less complete of the tendinous structures. In fractures due to direct violence, rupture of the tendon rarely occurs; when it does occur it is partial in character. In fractures which are the result of muscular action, the line of separation is transverse. Violence applied directly may produce fracture in the transverse, oblique, or vertical direction. In fractures caused by muscular action the important point is to direct the treatment so as to secure firm and close

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sometimes quite marked, experienced more especially at the time of the receipt of the injury. In fractures produced by direct violence the injury to the joint is of such character as to render the symptoms more or less obscure. Pain is marked. The separation of the fragments is much less, the deformity being caused largely by the swelling; loss of function varies in accordance with the severity of the injury. Crepitus can be more readily detected, owing to the slight separation of the fragments; in vertical and comminuted fractures it is readily obtained.

Diagnosis.—In transverse fractures caused by muscular action the symptoms are so distinct as to render the diagnosis usually easy, especially if the examination has been made before the supervention of much swelling. Transverse fractures produced by direct violence are sometimes difficult to recognize by reason of the slight separation of the fragments, owing to the non-occurrence of rupture of the tendon. In oblique or vertical fractures, or where the bone is comminuted, crepitus may be readily distinguished. In compound fractures the wound can be explored with the finger and the condition determined. As little movement as is consistent with a thorough examination should be made, so as not to increase the separation of the fragments.

Prognosis.—Fibrous union, with more or less separation of the fragments, and, as a result, with more or less disability, is liable to follow transverse fracture of the patella, with rupture of the tendon, due to muscular action. In transverse fracture caused by direct violence, close union by fibrous tissue is frequently accomplished. Rare instances are recorded in which bony union has followed transverse fractures produced by muscular action. The fragments in transverse fracture caused by direct violence, owing to the

non-rupture of the tendon, can be more readily approximated and maintained in coaptation, and in this form bony union may frequently occur. The disability varies very much in different individuals. I have observed instances in which patients, with wide separation of the fragments, apparently suffered no inconvenience, the full and free use of the limb being present. I have at this time a patient under observation, who had sustained transverse fracture of both patellæ, the result of muscular action, one fracture occurring a year subsequent to the other. Wide separation of the fragments exists, and the patient is liable to fall in walking rapidly. A peculiar form of disability accompanies this case, in that, while the patient is able to ascend the stairs naturally and without great effort, she is compelled, through the fear of falling, to descend backward.

More or less weakness of the limb is liable to follow in all cases. This fact explains the liability to the subsequent occurrence of fracture in the same bone, as well as in the bone of the other limb. In cases of wide separation, the bond of union is formed between the upper borders of the fragments, and consists of the expansion of fascia covering the anterior surface of the bone, increased somewhat in thickness by inflammatory action. When the separation does not exceed one inch and a half, fibrous tissue is developed between the ends of the fragments, filling up the space and forming a stronger connecting bond.

Treatment.—The indications for treatment are to overcome by proper measures the inflammatory conditions which are very frequently present, and then to apply such dressings as will maintain the fragments in close contact until union takes place between their surfaces, and in transverse fractures, of the edges of the torn tendinous structures. In order to

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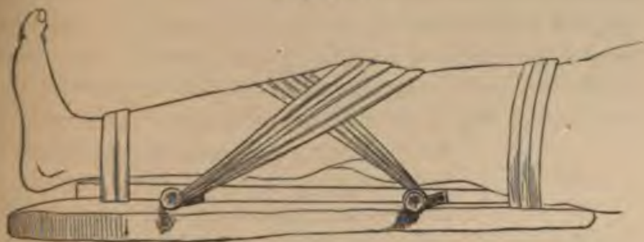
remove the inflammatory conditions present, it may be necessary to deplete the parts by the application of leeches and to apply evaporating lotions subsequently. In some cases the effusion of synovial fluid is so great as to demand its removal by the aspirating needle. Collections of blood in the joint require to be removed in the same manner. It may be desirable to place the limb at rest for a period of time—from four to six days—while this treatment is being carried out, and before any permanent dressing is applied.

A large number of appliances and dressings have been devised to maintain the fragments in proper coaptation. A few of them are effective, while a great number are not only not effective, but productive of bad results. In fractures due to muscular action, the limb should be placed in a complete state of extension upon a single inclined plane, with the body in the semi-erect position, so as to relax the quadriceps extensor muscle, and the dressings should be applied in such manner as to hold the upper fragment, after being placed in accurate contact with the lower, firmly in place. Bearing in mind the attachment of the tendon of the extensor muscle to the entire border of the bone, as well as to its anterior surface, suitable pressure should be made over the sides and anterior surface to prevent tilting upward of the edge of the upper fragment, and folding and wrinkling of the tendinous structures. A simple and effective dressing fulfilling these indications was employed by the late Prof. Gross, and consists of a strong, well-padded tin or wire case, long enough to reach from the middle of the thigh to the middle of the leg. A bandage having been applied to the limb from the toes upward, stopping below the knee, and another beginning at the groin and carried as far as the middle of the thigh, the limb is then placed in the case.

hinged together so as to form a single inclined plane with a foot-board. The piece for the limb is notched so as to hold securely the roller which envelops the knee. The plane having been padded, the limb is placed upon it, and the foot,

Fig. 141.



at right angles to the leg, is fastened to the foot-piece (Fig. 142). The body is placed in the semi-erect position, so as

Fig. 142.

to assist in relaxing the quadriceps muscle. The preliminary treatment of the fracture consists in the application of a

roller by oblique and circular turns above and below and over the knee, each turn passing through the notch. The limb is fastened to the splint by turns of the second roller, beginning at the ankle and passing over the knee by oblique and circular turns through the notch in the same manner as the first roller, and terminating at the groin. About the tenth day, the swelling having subsided, the permanent dressing consisting of strips of adhesive plaster, may be substituted for the first or uniting bandage. Careful inspection of the parts should be made daily for some time, the retaining bandage being removed for that purpose, and reapplied carefully with increased firmness as the swelling disappears. The covering in of the entire knee by the turns of the bandages prevents the tilting upwards of the edges of the fragments, and secures their perfect coaptation.

Fig. 143.

Recognizing the difficulty, by other dressings, of securing accurate contact of the fragments and of preventing the eversion of their edges, Malgaigne devised his hooks (Fig. 143). They consist of double hooks, at each end of sliding plates controlled by a screw, by which they can be approximated or separated. The hooks are inserted into the tendon at its point of insertion into the edge of the patella above and below—they are so shaped that they cannot penetrate the bone or the joint. Before applying the hooks, preliminary treatment should be instituted, if necessary, to remove all inflammatory conditions. Although a few cases have been reported in which erysipelas and even

fatal results have followed the use of the hooks, many have been treated without any complications and with the best results. They should be employed, however, with caution, careful attention being given to the condition of the parts during the progress of the treatment. It is desirable to place the limb upon an inclined plane, with evaporating lotions applied over the knee, and permit it to rest in this position for a period of six to eight days before applying the hooks. At the time of application the integument should be drawn very tense so as to prevent the formation of folds and its consequent contusion by the instrument. Very little dressing is required. Around and between the hooks lint charged with carbolized oil may be packed. If there is undue action of the extensor muscle present, the body may be kept in the semi-erect position and the limb placed upon an inclined plane. To secure complete relaxation of the quadriceps muscle, and as well quiet the fears of nervous patients, it is desirable to employ an anæsthetic at the time of the application of the instrument. Opinions differ as to the length of time required to keep the instrument in position. Some authorities state that they should remain from a period of six to eight weeks. Others believe that consolidation is effected in from two to three weeks. So long as they do not provoke irritation, it would seem desirable to permit the instrument to remain in position at least four weeks, and after its removal the knee should be covered by a firm bandage applied in figure-of-8 turns, and kept in a slightly elevated position.

It is my belief that separation of the fragments has occurred in many cases, in which good approximation had been effected during treatment by permitting the patient to use the limb at too early a period after union. It matters

not what form of dressing has been employed, the patient should be forbidden to use the limb in *any effort* under three or *four months*. If stiffness of the joint has occurred as the result of confinement of the limb in the fixed position, or as the result of inflammatory action, passive motion should be employed very cautiously [illegible] e surgeon during this period.

Drs. Levis and Morto[illegible] his city have used modifications of Malgaigne's hooks [illegible] good results in cases treated at the Pennsylvania Hospi[illegible]. Dr. Levis separated the original instrument into two [illegible]oks, while Dr. Morton modified it so as to form a dou[illegible] triangle (Fig. 144). The

Fi[illegible] 144.

objects to be accomplished by these modifications is the distribution of the pressure over a greater surface, and as a result the obtaining of more perfect coaptation.

Besides the appliances above described, many have from

time to time been devised and employed with varying success. The appliances of Lonsdale (Fig. 145) and of Boisnot (Fig.

Fig. 145.

146) are simple in construction, and act upon the same principle as those of Profs. Agnew and Hamilton.

Fig. 146.

In cases in which wide separation of the fragments has followed, despite of careful treatment, the disability consequent thereupon may be relieved by use of the apparatus devised by Messrs. D. W. Kolbe & Son, instrument makers, of this city (Fig. 147).

Compound fractures of the patella are very grave injuries, and may be followed by fatal results by the supervention of inflammation of a severe form. If the inflammation involves the structures of the joints and passes on to the stage of suppuration, the destruction of the joint is inevitable. The indications for treatment are eminently antiphlogistic in the first

stage, and tonic and supportive in the second. An effort should be made to convert, if possible, the compound nature of the injury into that of a simple one by closing the external wound. The limb having been placed on a bracketed splint (Fig. 140), antiseptic dressings should be applied, and on the occurrence of suppuration, free incisions should be made, and complete drainage should be accomplished by the introduction of drainage-tubes. The question of primary amputation, or of excision or amputation as a secondary operation, will present itself in many cases for serious consideration. In comminuted fractures all of the loose pieces should be removed. The value of antiseptic dressings is best shown in the treatment of injuries of this character.

Fig. 147.

LEG.—Fractures of the bones of the leg are of very frequent occurrence owing to their exposed position and to the fact that the violence sustained in falls upon the feet is liable to be expended first upon these bones. Examinations of records and museum collections of specimens show that both bones sustain fracture more frequently than either the tibia or fibula alone, and that the level at which the separation occurs is not the same: the point of fracture is most frequent in the lower third, and next in the middle. When both bones are broken the fracture of the fibula is usually at a level above that of the tibia. Of the two bones the fibula is

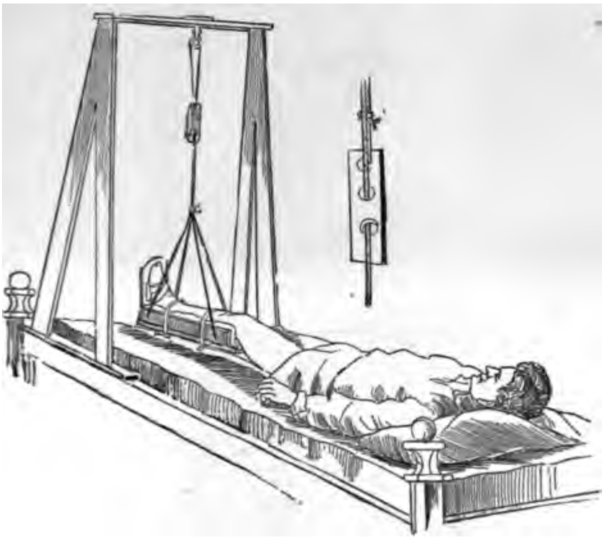
more frequently broken in the superior extremity than the tibia. Fractures of the bones of the leg are divided, for the purpose of study, into those of both bones—those of the tibia, those of the fibula.

Tibia and Fibula. *Causes.*—Direct and indirect violence, as well as muscular action, are the causes concerned in the production of fractures of both bones. The application of direct force in producing fracture is observed in the passage of a wheel of a wagon over the leg, the kick of a horse, or the crush of a mass of earth, or *débris* from the falling walls of houses in the process of demolition. Fracture, as the result of violence, applied indirectly, occurs in persons jumping from a height, and alighting on the feet, or from a railway train in rapid motion. When the fracture is caused by the direct application of force, the bones are severed at the point of contact of the force, and usually at the same level, the direction of the line of separation being more or less transverse. The application of indirect force produces fracture most frequently in the lower third, the separation taking place at different levels, and the direction of the line being oblique, either from behind downward and forward, or from without downward and inward. In fractures, the result of muscular action, the cause is found in the violent effort made by the person to regain his equilibrium at the time of a fall in which the body is thrown forcibly backward. The line of separation is, in this variety, frequently very oblique, and is usually from behind downward and forward. The level at which separation occurs in the two bones also varies. A man, thirty-five years of age, is now under my care for fracture of both bones, the result of muscular action. In walking upon the wet floor of the Morocco leather factory in which he was employed, he slipped, and

[redacted]

as may be desired. By this means the displacement in oblique fractures may be relieved in some cases without a resort to extension. Another method of suspension is seen

Fig. 150.



in Fig. 151, which is more elaborate, and requires, for its manufacture, the intervention of a mechanic. In cases in which the line of fracture is very oblique, producing shortening or marked lateral deviation, reduction should be effected by extension and counter-extension, and, when the displacement is lateral, replacement of the limb in the long axis of the body. The displacement in these cases may be overcome by treatment in the straight or flexed position. When

treated in the straight position, extension should be made by weights and pulley adapted to the limb placed in the fracture-

Fig. 151.

[redacted]

box, as seen in Fig. 152. Counter-extension can be effected, if necessary, by raising the foot of the bed as in fracture of the femur. Lateral support is secured by raising the sides of the box, in which a pillow has been placed. If the fracture is so near the ankle-joint as to prevent the attachment of the stirrup of plaster to the leg in the ordinary manner, strips of plaster may be applied in the form of the spica of the instep, as practised by Prof. Agnew (Fig. 153).

Fig. 152.

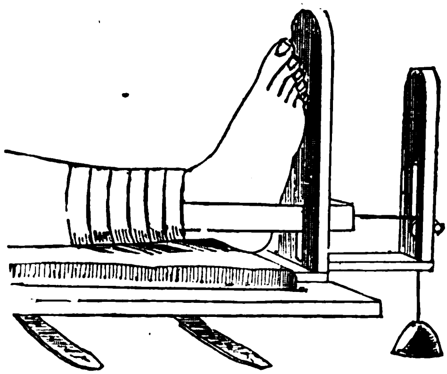
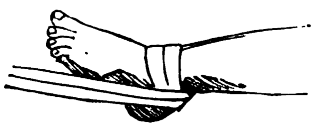


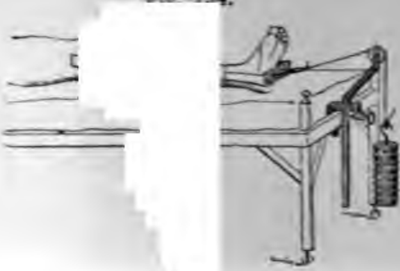
Fig. 153.



The apparatus of Dr. Levis, for making extension by weights and pulley in fractures of the femur, may be adapted

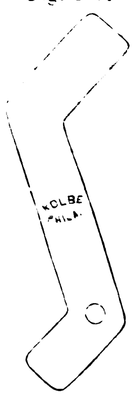
to use in these cases. The upright supporting the pulley can be attached to the foot-board of the bed, and the weights, equalling twelve pounds, are so arranged that they cannot be easily dislodged (Fig. 154).

Fig. 154.



Treatment in the flexed position may be accomplished by suspension of the limb, by means of the appliances used in fracture of the femur or leg, and by the double inclined plane, as modified in the method of Pott. The latter consists of a wooden splint made to adapt itself to a portion of the thigh, the entire leg, and foot when the limb is in the semi-flexed position (Fig. 155). An opening is made to receive the external malleolus, and the entire splint should be well padded so as to avoid pressure. The deformity being corrected by extension and counter-extension, and the limb placed in the semi-flexed position, the splint is applied to the external surface, the spaces intervening between the limb and splint being filled with masses of oakum or cotton-wool. An internal splint, made of binder's board,

Fig. 155.



extending from the knee to the ankle, should be moulded to the surface after having been moistened. It should also have an opening for the internal malleolus, and should be well padded. Both splints should be held in place by turns of a roller carried from the foot to the groin. With this splint in position the patient can rest upon the injured limb if desired without displacing the fragments.

When other appliances fail to secure coaptation of the fragments in oblique fractures, Malgaigne's steel pin may be employed. This consists of a segment of a circle formed of steel in the ends of which are slits to receive the straps which secures it to the inclined plane upon which the limb rests. The pin passes through an opening in the centre of the arch, and works by a screw. In using it the pin is screwed down, the point of the pin penetrating the tissues to the bone. The strap is drawn with requisite firmness to hold the pin whilst it is screwed down, so as to place the fragments in contact. The use of this instrument is condemned by some surgeons, and with justice, as it is liable to cause such inflammatory conditions as may give rise to erysipelas and suppuration, and produce, besides, the unfavorable conditions of a compound injury.

In simple fractures, in which the tendency to displacement is slight, an immovable apparatus may be applied at the end of the second or third week, and the patient may be permitted to leave the bed. This appliance may consist of two pieces of binder's board fashioned to the shape of the leg and foot (Fig. 156). A roller should be applied first, and then the splints, after being wet in hot water, should be moulded to the limb, well padded and secured in position by a bandage. This may be removed in three weeks, and a simple roller applied. Stiffness of the knee and ankle-joints

same proportion of cases as the fibula. The site of fracture may be in the upper, middle, or lower third, occurring most frequently in the lower third or the junction of the middle with the lower third. The line of separation is usually oblique and from without, downward and inward. Separation of the upper or lower epiphysis may occur, although the former is quite rare. Two years since I treated in the surgical ward of St. Mary's Hospital a child five years of age, who had sustained a compound comminuted fracture of the upper third of the left tibia, with separation of the epiphysis and dislocation at the superior tibio-fibular articulation, the result of a crush under the wheel of a street car. With the exception of severe contusion, the knee-joint was fortunately not seriously involved. The compound character of the wound permitted free inspection and digital exploration of the seat of injury. Under the use of the bichloride of mercury dressings, combined with *through-and-through* drainage, the limb was saved, with the loss of some pieces of necrosed bone and slight impairment of the function of the knee-joint. An interesting feature of this case was the straightening of the injured tibia by reason of the loss of bone and readjustment of the epiphysis and shaft. Owing to a rachitic condition of the child, the bones of both legs were curved outward.

Fracture in the upper extremity, extending into the knee-joint, is a very grave injury, and complicates the fracture in a serious manner, especially if compound in character.

Fracture of the internal malleolus may occur through the base at the point of junction with the shaft, in the middle or at the apex, the result of a twist of the foot, with forcible abduction or adduction.

Causes.—The causes of fracture of the tibia are similar to

those productive of fracture of both bones, namely, direct and indirect violence, as blows, kicks, and falls, and muscular action. The effect of muscular action is seen in old persons in whom a brittle condition of the bones exists.

Symptoms.—The symptoms of fracture of the tibia are sometimes less distinct than those of the fracture of both bones. Owing to the support afforded by the fibula, the deformity is, as a rule, not very great, although the over-lapping of the fragments may exist to some extent. Pain, discoloration, and swelling are usually present. Crepitus is difficult to elicit when the fracture is in the middle portion of the bone. At either extremity the parts can be manipulated in such manner as to develop it. Shortening to any marked extent is prevented by the resistance offered by the fibula. Preternatural mobility is more appreciable in fractures involving either extremity than in the shaft proper.

Diagnosis.—The subcutaneous position of the crest of the tibia will enable the surgeon, if the swelling is not too great, to detect the seat of fracture by passing the finger over the surface of the bone. In the upper extremity crepitus may be elicited by grasping the head and shaft and making rotation. In the lower extremity and in the malleolus crepitus may be detected by grasping the foot and making the movements of abduction and adduction. Pressure over the malleolus with the finger may distinguish the depression, which indicates the position of the site of fracture; if the fibres of the internal lateral ligament have been torn, the displacement of the fragment will be more marked, and the depression can be more distinctly felt.

Prognosis.—With regard to the results which follow fractures of the tibia the prognosis is generally favorable. In fractures of the upper or lower extremity involving the knee

or ankle-joint anchylosis to a greater or less extent may supervene. Union is sometimes retarded, and non-union may occur. The bond of union after fracture of the malleolus is usually fibrous in character. Deformity may follow after union by reason of the projection of the sharp end of one of the fragments. This process in time is generally absorbed, leaving a smooth and rounded surface. If this does not occur, and the point is painful and the patient apprehensive of injury occurring on account of the projection, it should be removed with the chisel or cutting pliers, or, what is preferable, with the large burr of the surgical engine. Union of the lower fragment to the fibula may occur, in this way, obliterating the interosseous space.

Treatment.—The treatment of fracture of the tibia is similar to that employed in fracture of both bones, and may be effected by the use of the wooden side splints, the fracture box, splints of binder's board, felt, tin, or wire in the manner already described for those fractures.

It is not regarded as essential in most cases to confine the patient in bed during the entire time required for union of the fragments, and it is desirable, after the subsidence of the swelling, which occurs at the expiration of ten days or two weeks, to apply an immovable dressing, which will afford sufficient support, and permit the patient to walk with the aid of crutches. The silicate bandage, with the addition of pieces of binder's board or tin to give firmness, may be applied, or the plaster-of-Paris bandage in the ordinary form or in that known as the Bavarian splint. The Bavarian splint or movable-immovable apparatus is made in the following manner: Two pieces of flannel of sufficient length and width to cover the leg and foot are cut and sewed together as is shown in Fig. 89. The limb is laid upon the

flannel, and each half of the inner layer is folded over the leg, and dorsum of the foot, joining at the median line, where the edges are fastened temporarily by pins (Fig. 90). Plaster, of proper consistence, is now applied over the inner layer, adapting it to the surface of the limb by a spatula or the fingers. When completely covered the outer layer is folded over the plaster, and pressed into place by the hand so as to conform to the shape of the limb. The pins fastening the edges of the inner layer are now removed, and the two layers of flannel, with the plaster between forming a firm splint, are bound together by three or four strips of bandage carried about the leg and foot. The double row of stitches fastening the two layers together forms a hinge at the back of the splint, so that it can be readily opened, and the parts inspected, or it can be removed, if necessary, and reapplied.

Firm union of the fragments does not occur until the expiration of five or six weeks, up to which period the dressings should remain in position.

In fractures of the upper extremity extending into the knee-joint careful attention should be given to the inflammatory conditions which are likely to occur and complicate the case. The appliance, which fulfils best the indications present in this form of fracture, is the long fracture-box with compresses under the knee to afford support. If much displacement of the upper fragment exists, it may be necessary to place a short splint, ten to twelve inches in length, beneath the seat of fracture, and then place the limb in the long fracture-box.

Fractures of the malleolus may be treated in the short fracture-box, the foot being placed in such position as to secure perfect coaptation of the fragments, and fastened securely to the foot piece. Lateral support should be

afforded by the sides of the box, protected by the pillow and masses of oakum or cotton-wool.

FRACTURES OF THE FIBULA.—Examination of tables of fractures shows that this bone suffers fracture in about the same proportion of cases as the tibia. Fracture occurs most frequently in the bone of the right leg, and oftener in the inferior third than in either the upper or middle portion. Between the ages of thirty and forty is the period of life when fracture occurs with the greatest frequency, the largest number being in males.

Causes.—The majority of fractures of the fibula are caused by violence indirectly applied, producing a separation of the bony fibres at a point from one inch and a half to three inches above the external malleolus. The application of the violence is accompanied by a forcible abduction of the foot, by means of which the astragalus is rotated and pressed with great force against the external malleolus, causing, in some instances, rupture of the internal lateral ligament, as well as fracture of the fibula. This takes place in twists of the foot or in falls upon the inner border of the foot. According to Boyer, fracture at the same point may occur as the result of forcible adduction of the foot in falls upon the outer border. Direct violence may cause fracture at any point of the bone.

Symptoms.—In fractures occurring in the upper and middle portions of the bone the symptoms are usually not very distinct. Careful examination is required to detect them. In the lower third, in that known as Pott's fracture, the symptoms are more prominent. Those which attend fractures generally are present as pain, swelling, discoloration, preternatural mobility, deformity, and crepitus. The displacement of the foot is characteristic, being markedly everted, and resting upon the inner border.

Diagnosis.—The protected and fixed position occupied by the upper two-thirds of the bone renders detection of the seat of fracture somewhat difficult. Pain, increased on movement, swelling, and discoloration are usually present, deformity and mobility are not marked; crepitus may be elicited by deep pressure exerted upon the fragments. The superficial position of the lower third of the bone, associated with its relation to the ankle-joint and foot, gives a more prominent character to the symptoms of fracture, and renders the diagnosis much easier. Great pain is experienced on motion. Swelling and ecchymosis are very marked; preternatural mobility is readily distinguished. The deformity varies in extent in accordance with the nature of the injury. In cases in which rupture of the internal lateral ligament co-exists with fracture of the fibula, the eversion of the foot is much greater than in fracture of the fibula alone. Crepitus may be elicited by grasping the foot, and making abduction and adduction alternately. The depression formed by the inversion of the ends of the fragments can be detected, if the swelling is not too great, by passing the finger over the surface of the bone; this sulcus can be increased in depth by abducting the foot. Dislocation at the ankle-joint may be distinguished from fracture of the fibula in the lower third by the absence of crepitus and the permanent removal of the displacement after efforts at reduction. Fracture of the external malleolus may be detected by grasping the process, and establishing the existence of crepitus and mobility by movement of the fragments.

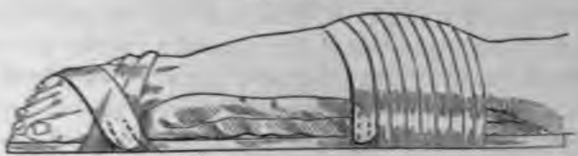
Prognosis.—Union by bone takes place in fracture of the fibula at all points, with the exception, possibly, of the external malleolus, where the union may be sometimes fibrous in character. More or less disability, with chronic enlargement

about the joint, is liable to follow cases in which the internal lateral ligament has been torn, accompanied by partial dislocation and injury to the ankle-joint. In neglected cases, or in those in which the treatment has not been properly conducted great deformity may ensue.

Treatment.—Fractures of the fibula in the upper and middle portions require in their treatment very simple dressings. Two pieces of binder's board, well padded, may be placed on either side of the leg, and secured in place by turns of the spiral reversed bandage, extending from the foot to the knee. This dressing will afford sufficient support to the fragments to maintain them in proper adjustment until union occurs. An immovable dressing, the silicate or plaster bandage, may be applied, and the patient be permitted to walk about with the aid of crutches. Fractures of the lower third of the bone, with slight displacement, may be treated by placing the leg in the fracture-box, care being taken to overcome completely the displacement by securing the foot, in proper position, to the foot-piece of the box. In cases in which rupture of the internal lateral ligament or fracture of the internal malleolus has occurred, the dressing must be of such character as will overcome the marked displacement which exists. That form which best accomplishes the purpose is known as Dupuytren's splint, and consists of an internal wooden splint, extending from the knee to a short distance below the foot, with a wedge-shaped pad of such length as will reach from the knee to the internal malleolus. The splint being well padded, is placed, with the wedge-shaped pad, upon the inner surface of the leg, the large end of the pad resting just above the internal malleolus. The upper end of the splint is fastened to the limb by a bandage, which is applied from the middle of

the leg to the knee. The foot is now adducted, bringing it in contact with the splint, and securing it in place by a figure-of-8 bandage, the turns of which should extend to the apex of the external malleolus, and *not* beyond (Fig. 158). In applying the two bandages care should be observed to

Fig. 158.



avoid beginning the application of the upper one too near the seat of fracture, and extending the lower one *beyond* the position of the external malleolus. In either event the objects of the dressing will be defeated in preventing the eversion of the fragments, so as to place them in coaptation. Attention should be given to the condition of the internal malleolus, and measures should be taken to avoid undue pressure upon it. After the lapse of eight to ten days, the reparative process having progressed far enough to maintain the fragments in place, the leg may be placed in the fracture-box, the foot being secured to the foot-piece, and lateral pressure exerted by the pillow, supported by the sides of the box. Masses of cotton-wool or oakum may be placed over the external malleolus to assist, if necessary, in making pressure.

Compound Fractures of the Bones of the Leg.—Of the bones of the leg the tibia suffers more frequently from compound fracture than the fibula, and, as a rule, more frequently than any other bone of the skeleton. The

explanation of this fact is to be found in the exposed position occupied by the bone, and in the relation it occupies to the foot and lower extremity as a portion of the column of support to the body. The character of the injury in compound fractures of the bones of the leg differs very much in different cases. In some the injury consists of a slight puncture of the soft tissues, produced by the sharp end of one of the fragments; in others, the rent in the overlying structures is very large, caused by the protrusion, to a marked extent, of the end, usually, of the upper fragment, with laceration of the soft structures, and in still other instances, as the result of great violence, there exists extensive protrusion of one of the fragments, with pulpification of the tissues and destruction of the arteries.

Causes.—The cause of compound fracture of the bones of the leg is usually great violence applied directly or indirectly. The effect of direct violence is seen in crushes by the wheel of a railroad car, a heavily loaded wagon, the falling of a wall, the kick of a horse, or a blow from a bludgeon. Indirect violence operates in producing compound fractures of these bones in falls upon the feet from a great height, or in a wrench of the leg, the foot being firmly fixed. Six years since, a lad, seventeen years of age, was admitted into the surgical wards of St. Mary's Hospital, who, in reaching out of an unguarded door, lost his balance, and fell to the ground, some forty feet distant, alighting upon his feet. He sustained a compound fracture of the left tibia, a simple fracture of the right fibula in the inferior third, and a simple fracture of the radius, also in the inferior third. The line of fracture of the tibia was very oblique, and the upper fragment, stripped of the periosteum, was protruded through the soft tissues to the extent of four inches. The

protruded fragment, covered with the detached periosteum, was replaced, and the patient at the end of four months was able to leave his bed with a useful limb.

Symptoms.—The symptoms of compound fracture of the leg are sufficiently distinct, and do not require description in detail.

Diagnosis.—In all cases careful examination should be made, in order that the exact nature of the injury may be determined, and that proper treatment may be adopted. Exploration with the finger, previously washed and immersed in an antiseptic solution, should be made. Much information as to the condition of the parts will be gained by this plan of examination. If hemorrhage is present, careful inspection and digital exploration will be necessary, in order to ascertain its extent and character.

Prognosis.—In compound fractures of the leg of not a severe character, the prognosis may be regarded as generally favorable. In those in which the soft structures have been much contused and lacerated, the inflammatory conditions which are liable to ensue will complicate the case, and render the prognosis doubtful. In fractures, caused by the application of very great violence, in which the bones are extensively comminuted, the soft tissues ground into a pulpy mass, and the bloodvessels lacerated, the prognosis is most unfavorable, the removal of the limb being demanded as necessary to save the life of the patient. More or less deformity is liable to follow union in all compound fractures, and anchylosis when the knee or ankle-joint is involved.

Treatment.—The question of making an attempt to save the limb in the treatment or remove it, is one which the surgeon is called upon to decide in cases of compound fracture of the leg. Good judgment is, therefore, to be exer-

cised, with careful consideration of all the conditions which present themselves in each individual case. The general condition of the patient's health, his habits of life, as well as the nature of the injury, are to be taken into careful consideration. In cases in which the external wound is small, and but slight laceration of the tissues has taken place, the limb should be placed on the pillow in the fracture-box, and an effort should be made to convert the fracture into a simple one by closing the wound. This may be accomplished, after cleansing it thoroughly and bathing with a dilute solution of carbolic acid, by introducing silver-sutures or drawing the edges together with adhesive plaster. An effort should be made to seal the wound hermetically, so that air cannot gain admission, by the application of collodion and gauze or other agents. Antiseptic dressings should be applied over the wound, and the limb kept at rest, in the hope that the external wound will promptly heal.

When the injury is of a more serious character, with protrusion of the fragment, and extensive laceration of the soft structures a different plan of treatment should be pursued. The protruding fragment should be replaced by manipulation —flexion and extension, with counter-extension of the limb, being employed in turn, if necessary, to effect this. Separation of the edges of the wound with retractors, or enlargement of the opening by incision may be practised if replacement is found difficult. It may be necessary, in some cases, to remove with the cutting-pliers or saw, a portion of the fragments, in order to reduce the fracture. All other means should be exhausted before resorting to this operation, as it leaves the fragments in such condition as to interfere with the reparative process. The fragment being replaced, the edges of the wound may be drawn together, and secured by

sutures if the laceration of the tissues is not too great. It is desirable, in these cases, to introduce drainage-tubes, and bring the edges of the wound together about them. By this means the wound-fluids will be removed, and the tendency to suppuration averted. Antiseptic dressings should be applied to the wound, and the limb placed in the fracture-box or in an immovable dressing, with a fenestrum over the wound, as shown in Fig. 91. A favorite plan of dressing employed in this city in these cases, consists in placing the limb in the fracture-box, and surrounding it with coarse bran, as originally practised by Dr. John Rhea Barton. The bran affords equable pressure, and absorbs the discharges from the wound as they appear. Removal of the soiled bran, and the addition of that which is clean is readily effected. In compound comminuted fractures the loose and detached pieces of bone should be removed, and drainage-tubes should be introduced, so as to drain the wound thoroughly. If suppuration occurs, counter-openings may be made, if found necessary to secure complete drainage. Antiseptic dressings should be employed in all cases of compound fractures of the leg, and immobilization of the fragments should be secured by appropriate appliances. With the aid of this form of dressing limbs formerly condemned for removal are saved and made useful.

Hemorrhage, venous or arterial in character, frequently occurs in connection with compound fractures of the leg, and increases their gravity. Venous hemorrhage may be controlled by pressure exerted uniformly upon the parts, or by the application of cold compresses. Care should be taken that the blood is not confined in the wound, where it may collect and lead to suppuration. If arterial hemorrhage does not yield to pressure or other simple measures,

the wound should be enlarged, if necessary, the bleeding vessel sought, and a ligature applied. Hemorrhage from the nutrient artery is sometimes severe. It may be controlled by plugging the canal temporarily with a piece of soft wood, or permanently with a piece of animal ligature.

FOOT.—Simple fractures of the bones of the foot are rare. The astragalus and os calcis are the bones of the tarsus which most frequently sustain fracture. Of the metatarsus and phalanges those of the great toe are most frequently broken. Compound fractures occur very frequently.

Causes.—Direct and indirect violence and muscular action are assigned as causes. The os calcis, with the metatarsal bones and phalanges, sustain fracture as the result of direct force, as in the crush of the foot under the wheel of a car. Instances are recorded in which forcible contraction of the calf muscles has produced fracture of os calcis. The astragalus is generally broken by force transmitted through the os calcis, as in falls upon the feet. The direction of the line of fracture varies in the different bones, being transverse, vertical, and horizontal.

ASTRAGALUS. *Symptoms.*—Wedged in as the astragalus is between the malleoli, it is impossible, as a rule, in simple fractures, to observe any symptoms characteristic of fracture. Pain and swelling, with loss of function may be present. Crepitus may be detected by manipulation, flexion and extension, or abduction and adduction of the foot. Deformity is not usually present.

Diagnosis.—The absence of marked symptoms in simple fractures renders the diagnosis very difficult. If displacement exist the seat of fracture may be detected. Crepitus, if obtained, will assist in making the diagnosis. In com-

pound fractures the parts can be inspected and explored with the finger.

Prognosis.—Favorable in simple fractures. In compound and comminuted fractures the involvement of the ankle-joint, and, in some instances, of the adjacent tarsal joints renders the prognosis very unfavorable. If amputation or excision is not demanded, anchylosis, more or less complete, will follow repair.

Treatment.—In uncomplicated cases the treatment consists in placing the limb for a few days in the fracture-box, and applying the applications locally to allay the swelling. When this has subsided an immovable dressing of plaster or silicate of sodium should be applied, and the patient should be permitted to walk about with the aid of crutches. When displacement of one of the fragments exists, an effort should be made, by manipulation, to reduce it, which is frequently an unsuccessful operation. If reduction cannot be effected it is thought desirable by some authorities to permit the fragment to remain in its displaced position, with the accompanying deformity. Other authorities are equally strong in their opinion that excision, not only of the fragment, but of the whole bone, should be performed, in order to remove deformity and disability. The excision of the entire bone is recommended on account of the danger of the occurrence of necrosis in the remaining fragment, and of the consequent involvement of the bones of the ankle-joint.

In compound and comminuted fractures the question of amputation or excision presents itself for serious consideration. The action of the surgeon should be based upon a careful consideration of all the conditions present.

Os Calcis. *Symptoms.*—The symptoms of fracture of the os calcis vary in accordance with the position of the

fracture. If it is sub-astragaloid in character, the transverse diameter of the bone is increased, while the vertical is diminished, giving rise to a decided flattening of the heel. Pain, increased on movement, is present, whilst the swelling is circumscribed in character, being confined, according to Malgaigne, as quoted by Prof. Agnew, "to the parts below the front of the ankle and the malleoli, and to the sole of the foot." In this form of fracture the bone is generally comminuted, and sometimes impacted. Crepitus is difficult to elicit by reason of this impaction. In fracture of the post-astragaloid or heel portion of the bone, the symptoms, owing to its connection with the calf muscles and its prominent projection, are more distinct. Pain and swelling are present, with mobility and deformity. The deformity is produced by the action of the gastrocnemius and soleus muscles, which draw backward and upward the posterior fragment. This displacement upward is especially marked if the line of separation is near to the insertion of the tendo Achillis. Crepitus can be detected by flexing the knee and ankle-joints, and, after grasping the fragment, making rotation.

Diagnosis.—The diagnosis is made by a careful examination and study of the symptoms as they present themselves in the two forms of fracture. In the subastragaloid variety they are somewhat difficult of recognition, whilst in fractures of the heel portion they are sufficiently distinct to render the diagnosis easy.

Prognosis.—Disability to a greater or less extent is liable to follow fracture in the sub-astragaloid portion of the bone. In the post-astragaloid variety of fracture union occurs, under ordinary conditions, in the usual period—five or six weeks—and usually without great disability.

Treatment.—In the post-astragaloid variety of fracture the indications for treatment are to adopt such an appliance as will place the fragment in contact with the bone, and maintain it in this position. This can be accomplished by flexing the leg upon the thigh, and the foot upon the leg. The fragment should then be drawn down into place, and secured by the application of a strip of adhesive plaster, or the turns of a figure-of-8 bandage of the instep. The limb in the flexed position should be secured to a double angular splint (Fig. 155) by turns of a roller carried from the foot to above the knee. When the swelling has disappeared an immovable dressing may be applied in place of the splint. Other forms of dressings have been employed. Fig. 159 shows that of Monro, which consists of a wooden splint, placed on the front of the leg and over the dorsum of the foot.

Fig. 159.

In the sub-astragaloid variety of fracture, an immovable dressing may be applied when the inflammatory conditions have subsided.

METATARSUS. *Symptoms.*—The symptoms of fracture of the metatarsal bones are well marked. Occurring as the result of direct violence the displacement is not great. Mobility and crepitus are present, and easily recognized.

Diagnosis.—As in the metacarpus, the parts are so readily accessible that the diagnosis is not attended with any difficulty. Crepitus can be easily elicited by grasping the parts and moving the fragments upon each other.

Prognosis.—The prognosis in fractures of the metatarsal

bones is favorable, union taking place without difficulty. In compound and comminuted fractures deformity may follow as the result of the injury.

Treatment.—In simple fractures the fragments should be reduced, and the limb placed in a fracture-box, with the foot secured to the foot-piece by a handkerchief in cravat form, or a splint of binder's board may be moulded to the posterior surface of the leg and plantar surface of the foot, and, after being well padded, may be secured in place by turns of a roller. An immovable dressing applied to the foot and leg will afford an excellent support in fractures of this kind. Compound fractures should be treated with antiseptic dressings and appropriate splints to secure rest.

PHALANGES. *Symptoms.*—Simple fractures of the phalanges are attended by the usual symptoms of fracture, as pain, swelling, mobility, and crepitus. Deformity is not usually well marked, except, perhaps, in cases of fracture of the phalanges of the great toe. Compound fractures, the result of a crush by the falling of a piece of timber or metal upon the toes, present prominent symptoms. The parts can be examined easily, and the nature of the fracture determined.

Diagnosis.—The diagnosis may be difficult in simple fractures of the smaller toes. In the great toe, where fracture occurs most frequently, the symptoms are so distinct as to render the diagnosis easy.

Prognosis.—Union may occur with some deformity, otherwise the prognosis is favorable.

Treatment.—In simple fractures, a wooden splint or one made of binder's board, after being well padded, may be secured to the plantar surface of the foot by turns of a roller. Strips of adhesive plaster may be applied about the toe to maintain approximation of the fragments, if found

necessary. If anchylosis is threatened, the toe shoul
placed in the *straight* position, so as to avoid pressure o
shoe on a permanently flexed joint. An immovable d
ing extending to the leg may be substituted for t
described.

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PART IV.

DISLOCATIONS.

DEFINITION.—A dislocation or luxation is a separation of the surfaces of the bones entering into the formation of an articulation or joint.

VARIETIES.—1. Traumatic; 2. Pathological; 3. Congenital.

1. TRAUMATIC DISLOCATIONS are the results of injuries, and are divided into Complete—Incomplete—Simple—Complicated—Single—Double—Unilateral—Bilateral—Primitive—Secondary—Recent and Old.

Complete Dislocations are those in which an entire separation of the articular surfaces occurs, accompanied by an elongation or rupture of the ligaments of the joint.

Incomplete or Partial Dislocations are those in which the separation of the articular surfaces is not complete, a portion of the surfaces remaining in contact, with, as a rule, elongation and not rupture of the ligaments.

Simple Dislocations.—Dislocations are designated as *simple* when they are unaccompanied by any other condition than separation of the articular surfaces, with or without rupture of the ligaments.

Complicated Dislocations.—Those which are attended by lesions in addition to the separation of the articular surfaces,

as fracture of one or all of the bones entering into formation of the joint, the production of a wound of the soft tissues communicating with the articulation, wounds of important bloodvessels or nerves, or extensive contusion and laceration of the soft structures.

Single Dislocations.—Dislocations involving one joint only are designated *single.*

Double Dislocations are those in which the luxation occurs in corresponding articulations on both sides of the body.

Unilateral Dislocations.—These take place in one articulation of a single bone.

Bilateral Dislocations.—The dislocation is bilateral when a separation of the articular surfaces occurs in both articulations of the bone.

Primitive Dislocations.—The term *primitive* is used in connection with dislocations to designate the original position in which the bone is placed.

Consecutive Dislocations.—A consecutive or secondary dislocation is one in which the bone, for some cause, assumes a new position.

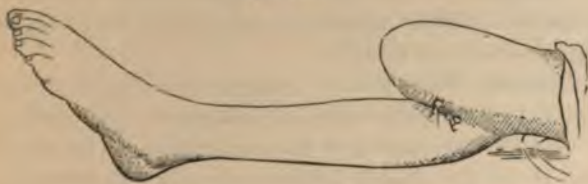
Recent Dislocations.—The term *recent* is applied to dislocations occurring within a short period of time—as a few days or weeks—before any changes have taken place in the parts.

Old Dislocations.—Dislocations are designated as old when some time has elapsed since the receipt of the injury—from a few months to a year or more—after the occurrence of such changes in the articulation as to greatly impair or destroy it.

2. Pathological Dislocations are those in which the separation of the articular surfaces has taken place as the result of disease in one or both. This condition is most fre-

quently observed in the hip- and knee-joints consequent upon chronic inflammation. As a result of the inflammatory action the structures of the joint are partially or completely destroyed, so that they cannot resist the muscular contraction exerted, and therefore the distal or movable bone is drawn away from the articular surface or cavity, in contact with which it is normally placed. The separation is progressive, and extends sometimes to the distance of three or more inches (Fig. 160).

Fig. 160.



3. Congenital Dislocations are those which occur during the life of the fœtus in utero, and may be caused by external violence, disease of the articulations, or arrest of development. They occur most frequently in the shoulder-, wrist-, or hip-joints, and in females oftener than in males. Accompanying the dislocation, and in some instances caused by it, are marked alterations in the articulations and in the structures about them.

Causes of Dislocation.

Predisposing and Exciting.—Predisposing causes embrace *age*, *sex*, *occupation*, *articular disease*, and *peculiar formation of the articulation.*

Age.—Age exercises an influence in the production of dislocations in the development and decline of the muscular power. Dislocations occur most frequently in middle life—rarely, as a rule, in very young or old age. The development of the muscular structures in middle life contributes to the occurrence of those luxations caused by muscular action.

Sex.—Dislocations occur more frequently in males than in females, the explanation of which is to be found in their different modes of life.

Occupation.—This cause conduces to the occurrence of dislocations in the exposure to injury incident to the occupation of the individual.

Articular Disease.—The changes occurring in an articulation due to morbid conditions predispose to dislocations.

Peculiar Formation of the Articulation.—The construction of the articulation influences largely the occurrence of dislocation. Those in which motion is extensive, as the ball-and-socket joints, are much more liable to suffer from luxation than the hinge-joints.

The EXCITING causes of dislocations are *external violence* and *muscular action.*

External violence may exert its influence in two ways—directly and indirectly. The effect of the former is observed in the application of force directly over the articulation, and of the latter in the transmission of the force from a distal part to the joint, upon which it is expended.

Muscular Action.—This cause is effective in violent and spasmodic action of the muscles, the articular surfaces being at the time in a position favorable to separation under its influence.

In discussing the causes of dislocation it is desirable to

consider, as an important factor in their production, the relative position of the articular surfaces at the time of the application of the force. A partial separation of the surfaces, with a relaxed condition of the surrounding structures, and the position of the distal bone at an angle to the articular surface above, favor very materially the production of dislocation.

Pathological Characters.—An examination of an articulation recently the subject of a complete dislocation, will reveal a laceration of the ligaments more or less extensive with separation of the articular surfaces. The condition observed in the ligaments varies—in some instances there is an elongation, with a slight rent sufficient only to permit the escape of the bone—in others, the laceration is extensive, the ligaments being torn from their bony attachments. In dislocations, the result of very violent force, the muscles and tendons are contused, and in some cases lacerated. In luxations caused by muscular action the laceration of the ligaments is much less extensive, the displacement being accomplished rather by elongation with slight rupture. Capsular ligaments, it is observed, suffer more extensive laceration than those formed of bands.

As a rule, the large bloodvessels in relation with the articulation escape injury, the bleeding which follows luxation being caused by the rupture of the small articular branches. Laceration of the large nerves is an extremely rare accident. Frequently they are subjected to pressure producing numbness, and in some instances neuralgic pains and paralysis.

The separation of the articular surfaces varies in accordance with the amount of force applied in producing the dislocation, the extent of rupture of the ligaments and the manner in which the muscular action is expended upon the

displaced bone upon a large nerve. Instead of pain, patients will sometimes complain of numbness extending the entire length of the limb.

Loss of Function.—As a rule, loss of function is very marked in dislocations, the patient being unable to make, if any, but the slightest movement of the limb.

Deformity.—Deformity manifests itself in different ways, as to change in the contour of the joint, the length of the limb and its axis. The configuration of the joint is always more or less affected; this is observed in some articulations in the absence of the natural rotundity of the parts, a flattened appearance being presented in its place, with the prominent projection of the bony processes. With few exceptions the limb is shortened under the influence of the muscular action, the extent of shortening varying in different dislocations. In some forms of dislocation great distortion attends the condition, and the axis of the limb is notably affected, being markedly abducted, inverted, or everted, as influenced by the position of the displaced surfaces and the muscular action.

Immobility.—Immobility is one of the most prominent and constant symptoms of dislocation. In complete luxations the interference with the normal movements of the joint is very marked and most readily recognized. In dislocations affecting certain articulations the immobility is almost absolute. The patient is unable to exercise any control over the movements of the limb, and the efforts of the surgeon are unavailing in effecting more than a very limited motion. The rigidity of the limb is due to various causes which may act separately or conjointly; these are muscular action, the obstruction offered by prominent bony processes, and the constriction produced by the ruptured ligamentous structures.

In addition to the symptoms above enumerated, there may be swelling, discoloration, and crepitus, or friction sound.

Swelling, if it occurs immediately or very soon after the receipt of the injury, is due to hemorrhagic effusion and is soon followed by marked discoloration. Appearing at a later period it may be regarded as the result of inflammation, and increases with greater or less rapidity in accordance with the intensity of the action. Effusions of blood may precede and accompany the deposition of inflammatory products, and their combined effect will increase the swelling and discoloration, rendering the part hard, glossy, very painful and intolerant of manipulation.

Manipulation of the injured joint in some instances gives rise to a sound which has been designated by some authorities as *crepitus*. The sound produced is quite different from that elicited in fractures as the result of moving the fragments of broken bone upon each other with their surfaces in contact. Friction expresses better the sound heard, and is properly applied to indicate the cause which is ascribed to the presence of an exudation of plastic matter in the joint. It is a very uncertain symptom and cannot be relied upon in making a diagnosis.

Diagnosis.—There is no class of injuries in which a thorough knowledge of anatomy is more requisite, in order to comprehend the conditions present, than in dislocations. The surgeon must have a knowledge of the normal anatomy of the articulation before he can appreciate the departure from this which exists in luxation. He must understand the relations of the different surface markings to the articulation and to each other to enable him to recognize any change which may occur in them. In arriving at a correct interpretation of the symptoms present, careful examination

is necessary. The injured joint should be inspected and compared with that of the opposite side as to contour, mobility, and function. Measurements should be made to determine any differences which may exist as to length and width of the limb and affected part. It is desirable, in almost all cases, especially in luxations involving the larger joints, to make the manipulations necessary under the influence of an anæsthetic agent. The removal of muscular spasm and the complete relaxation of the muscular system obtained by anæsthesia is essential to a satisfactory examination of the part. Moreover, reduction may be effected whilst the patient is in this condition if dislocation is found to exist.

The differential diagnosis between dislocations, fractures near to or involving a joint, and sprains, requires a careful study of the symptoms of each and their comparison. Pain, loss of function, and deformity, are common to all, although differing in character in each; the characteristic symptoms of fractures are preternatural *mobility* and *crepitus*, while those of dislocation are preternatural *immobility* and *absence of crepitus*. In sprains the normal movements are limited only, not abnormally increased or entirely prevented, and crepitus is absent. In both dislocations and sprains friction sounds may be detected after the supervention of inflammation.

It is desirable to make the examination in cases of dislocation as soon after the receipt of the injury as possible, before the occurrence of swelling and other conditions liable to render the diagnosis difficult.

Prognosis.—The prognosis, as far as it relates to reduction is, in recent dislocations, favorable. In old dislocations it is very unfavorable as will be seen further on. More or

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less disability with disordered sensibility remains after dislocation in almost all cases. The danger to life attending dislocation is, as a rule, slight, and differs in accordance with the character of the injury and of the joint involved. In recent cases, dislocation of a ball-and-socket joint is more difficult to overcome than of a hinge-joint. Reduction, however, can be effected in an enarthrodial joint with greater ease after a lapse of time than in the ginglymoid variety.

In females, old persons, and children, reduction is more readily accomplished than in adult males, owing to their slight or impaired muscular development.

Treatment.—The treatment of dislocations consists in the restoration to the normal position of the separated articular surfaces, their retention in place by suitable dressings until the injured structures are repaired, the application of such remedies as will allay inflammatory action which may occur, and the employment of such measures as will restore the normal functions of the joint.

Reduction of the dislocation may be effected by means of manipulation or the application of force. In effecting reduction by manipulation the patient should, as a rule, occupy the recumbent position, and should be placed under the influence of an anæsthetic. The administration of an anæsthetic may not be necessary if the patient is seen immediately after the receipt of the injury, when the absence of strong muscular action and the condition of shock present, may facilitate the reduction of the dislocation. The patient being completely under the influence of the anæsthetic, with the muscles in a state of relaxation, the surgeon should make a careful examination so as to ascertain the position of the displaced bone, the site, if possible, of the rupture in the ligamentous structures through which it has escaped,

and the structure offering obstruction to its return, whether a tendon of a muscle or a bony process in relation with the joint, or the tightly drawn edges of the rent in the ligament. He should also endeavor to determine the course taken by the bone at the time of the displacement, in order to direct his manipulative efforts, so as to accomplish its return with the least resistance.

The manipulations should consist of extension, counter-extension, and pressure, with, if required, the movements belonging to the articulation, as abduction, adduction, flexion, and rotation. The movements necessary to be made having been determined upon they should be executed with deliberation and in a systematic manner. If, in their execution, reduction is not effected, an examination should be made to ascertain the cause of obstruction, and, if possible, this should be overcome by manipulations performed in other directions. In this manner a bone may be relieved from a fixed position and the luxation, which had before resisted all efforts, reduced. Aimless movements should not be made, as they have a tendency to increase the difficulties in effecting reduction by further displacement of the bone and to cause laceration of the tissues.

Reduction by force is accomplished through the instrumentality of certain appliances by means of which it is most effectually applied. In this method counter-extension is effected by the efforts of an assistant who grasps the part, or by strong counter-extending bands.

Extension is made by the surgeon in the direction of the long axis of the limb by grasping it with the hands or through the median of the clove hitch (Fig. 161), or Indian basket, or other contrivance which enables him to accomplish traction with better advantage.

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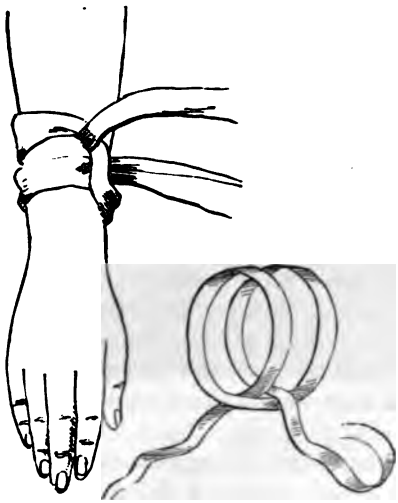
Fig. 161.



If greater mechanical power is desired it can be obtained by the use of the compound pulleys (Fig. 162), the rope windlass, the dislocation tourniquet, or Jarvis's adjuster.

In the application of the compound pulleys the patient should be in the recumbent position, and a soft, wet napkin or towel long enough to go around the limb twice should be applied. Over this the noose or clove hitch, made from some strong and soft material folded in the form of the cravat, should be placed and one hook of the pulleys fastened to it. The other hook should be secured to a staple screwed into the door jamb or other convenient place. The cord should then be gradually tightened, great care being taken to apply the traction so as to avoid the infliction of injury to the soft structures, or to produce fracture of the bone.

Fig. 162.

With the appliances above mentioned great force can be exerted, and they should, therefore, be employed with the utmost caution.

That they have done injury, even in the hands of skilful surgeons, is unquestioned, and it is desirable that their use should be entirely dispensed with. The success which has attended the employment of manipulation in effecting reduction of recent and also of old dislocations justifies the belief that their application is not necessary in any form.

Continuous extension, exerted by rubber bands or by weights, has been successful, in a number of instances, in reducing luxations which have resisted other methods.

Subcutaneous division of muscles, tendons, ligaments, and fibrous bands, which have offered unyielding obstruction to the return of the dislocated bone, has been practised by Diffenbach and others. The operation is attended with danger to vessels and nerves in relation with the articulation, and is liable to give rise to inflammatory conditions. I have seen a fatal result follow its employment by a most skilful surgeon.

The evidence that reduction of a dislocation has been effected is found in a decrease of the pain, the removal of the accompanying deformity, with more or less complete restoration of the functions of the limb. In some instances, the return of the bone is accompanied by a distinct snap, which is heard by those present. In other cases, owing to the relaxed condition of the parts under the influence of the anæsthetic, the bone returns to its place without this sound.

The treatment after reduction consists in combating inflammation, if present, by appropriate remedies, and in the application of dressings to retain the bone in place; these should remain in position for different periods of time, according to the character of the dislocation.

At the expiration of ten days to two weeks passive motion, with friction, should be instituted to prevent anchylosis and restore the functions of the joint.

Complicated Dislocations.—As stated above, various conditions complicate dislocation, and among them fracture of the displaced bone and the compound character of the dislocation are of the greatest importance, and require special directions as to the treatment to be adopted. In cases where it is possible, the fracture should be first reduced and the fragments retained in apposition by appropriate dressings. A primary roller should be applied to the limb, and the fracture supported by the application of a number of well-padded narrow splints, which should be secured in place by a second roller. Under the influence of an anæsthetic, reduction of the dislocation should now be effected by careful manipulation or force, the limb being grasped over the splints, and if possible, above the seat of fracture. Dressings should be applied after reduction, to prevent the recurrence of displacement. If the seat of fracture is so near the joint as to

prevent proper immobilization of the fragments prior to efforts at reduction of the dislocation, these should be made first, the surgeon endeavoring by pressure upon the displaced bone to reduce it. Dressings should then be applied, which will have the combined effect of retaining the displaced bone and fragments of the fracture in place.

Compound dislocations occur as the result of external violence applied over the joints, or the forcible extrusion of the dislocated bone through the structures. In the former, the wound is made from without inward, and in the latter, from within outward. The causes of the injury are blows, producing usually the dislocation from without inward, and falls, in which the application of the indirect force protrudes the bone through the tissues. The articulations most liable to suffer from this form of injury are the elbow, knee, and ankle, all of the ginglymoid or hinge variety.

The *symptoms* are so plain as not to require special description.

The *diagnosis* is not difficult, owing to the ease with which the parts can be examined by inspection, and, if necessary, explored with the finger.

The *treatment* of these injuries demands the most careful consideration. The great responsibility of decision in these cases with regard to the question of removal of the limb or of an attempt to save it, rests upon the surgeon, and he must act promptly. The presence of the following conditions are usually regarded as sufficient to justify the surgeon to resort to immediate amputation: Extensive contusion and laceration of the soft tissues with free exposure of a large joint, great comminution of the luxated bone, rupture of large arteries or nerves, and finally, the advanced age of the patient, the existence of ill-health or dissipated habits. Am-

putation as a secondary operation may be required later when after an attempt to save the limb has been made, gangrene or exhaustive suppuration has supervened. Still further, amputation may be performed with propriety, where great deformity, impairing markedly the function of a limb, follows conservative treatment.

Primary excision may be performed with advantage instead of amputation, where some of the conditions above stated exist, especially in those involving the shoulder-joint. It may be performed secondarily in cases in which necrosis has attacked the bones of the joints.

When, after careful consideration of all the conditions present, it is decided to make an effort to save the limb, the following plan of treatment should be pursued. The parts should be thoroughly cleansed with a one to forty solution of carbolic acid, or one to two thousand solution of corrosive sublimate, using for this purpose the fountain syringe. If comminution of the bone exists, all loose fragments should be carefully removed with the forceps or fingers of the surgeon. When the displaced bone protrudes through the wound it should be returned by manipulation. Extension with pressure upon the extremity may be able to effect this. If it is firmly grasped by the edges of the rent in the tissues they should be separated by means of retractors, and if this is not sufficient the opening may be cautiously enlarged by incision with the probe-pointed bistoury. It may be necessary in some cases to divide certain muscles or tendons, the tension of which cannot be overcome by manipulation, and also to remove with the saw or cutting pliers the end of the displaced bone which interferes with reduction; this last operation should be left, however, as a *dernier ressort*, the objections obtaining against this procedure being the

same as in compound fracture. With regard to the removal of the *uninjured* articular surfaces, Prof. Agnew states that in his experience "it is the safest course to cut away the displaced ends of the articulating bones." The late Prof. Gross was, on the contrary, very emphatic in his declaration "that retrenchment should be performed in cases only where the end of the bone is sharp, angular, or denuded of periosteum, and such a step should be taken only after the most thorough conviction of its imperative necessity. He could hardly conceive of a case where it would be necessary to remove the end of a dislocated bone, simply because it protrudes at a wound."

The displaced bone having been reduced and the ligaments carefully adjusted so as not to rest between the articulating surfaces, drainage-tubes should be introduced to secure complete removal of the wound fluids and the edges of the wound accurately approximated by silver sutures or adhesive plaster. The corrosive sublimate dressings should be now applied and retained in place by bandages. If the injury occurs in the upper extremity, immobilization should be effected by appropriate splints, such as those described in connection with compound fractures involving the articulations. In compound dislocations involving the joints of the lower extremity, the patient should occupy the bed, and antiseptic dressings should be applied with the fracture-box, bracketed splint, or plaster bandage, with fenestrum over the wound, to secure perfect rest and quiet. In the event of an inability to employ antiseptic dressings, the treatment may be conducted by irrigation of the parts or the application of compresses wet in the laudanum and lead-water solution. The inflammation which supervenes should be treated by the administration of appropriate constitutional remedies, and when

suppuration occurs, by means of stimulants and tonics. It is of the utmost importance that perfect drainage of the wound should be accomplished in order to prevent the evil results liable to follow the inflammatory action.

Old Dislocations.—Under the head of pathological characters, the changes which take place in the joint and surrounding structures in unreduced luxations of long standing were fully discussed. Considering these conditions, an important question relates to the period of time at which the surgeon may, with propriety, institute efforts at reduction, and the manner in which the treatment should be conducted. While it may be impossible to fix any period arbitrarily in which reduction may be effected for the articulations in general, the rule laid down by Sir Astley Cooper may be accepted as a safe guide. It was his opinion that the limit of time in which it would be prudent to attempt reduction of the shoulder-joint was three months after the receipt of the injury, and two months in cases of dislocation of the hip-joint. Cases are recorded in which dislocation of both shoulder- and hip-joints have been reduced at much longer periods after injury than those given above, as for instance, several cases of the shoulder-joint, by Dr. N. R. Smith and others, at periods varying from seven to ten and a half months, and a number of the hip-joint by Drs. Travers, Blackman, and others, from five to nine months. These cases are exceptional, and occurred, no doubt, in persons of advanced age, or in those in whom the ligamentous and other tissues were in a very lax and elongated condition. Some years since, I was called upon to reduce a dislocation of the shoulder-joint of twenty-four months' standing, in a female of advanced years, in whom the tissues were so lax that it was quite easy to produce a recurrence of the displacement. In the gingly-

moid form of articulations the period at which reduction may be accomplished, is still more limited, not extending usually beyond three or four weeks.

The dangers which attend efforts at reduction in cases of long standing have been alluded to, and relate to the injury liable to be inflicted upon the structures about the joint, consolidated by inflammatory deposits. Those most important are the vascular and nervous trunks, which are involved in the mass of tissue and become thickened and contracted.

No efforts at reduction should be attempted without first informing the patient of the dangers which attend the operation. If it is deemed prudent to attempt reduction, preliminary treatment, extending over a period of two weeks, should be instituted, the purpose of which is, by intelligently conducted movements to break up adhesions formed, and to overcome, to a certain extent, the rigid character of the structures involved. These movements may be assisted by manipulations and frictions with the hand, using at the same time soap liniment or some unctuous agent to soften and relax the tissues. At first, it is desirable to execute these movements but once in the twenty-four hours. Later they may be performed twice in the day. Purgatives and minute doses of mercury may be advantageously administered to avert inflammation and to assist in promoting absorption of plastic deposits.

When the preliminary treatment is terminated the patient should be placed under the influence of an anæsthetic, and the attempt at reduction made with great care. The efforts should be conducted in such manner as to elongate the structures so that the articular surface of the displaced bone may be placed upon a level with that of the opposing bone. The extension to accomplish this must be made *slowly* and *de-*

berately; by this manœuvre alone the bone may be replaced,
' not, other manipulations should be associated with it, with
view to return the bone through the opening in the liga-
ient, which, it is natural to infer, will be much contracted in
ze, and the edges thickened and rigid. Violent and forci-
le efforts should be avoided, as they may result in the lace-
ation of a bloodvessel, or nerve, or fracture of the bone.
f the effort at reduction fails, the joint should, for the time
eing, be placed at rest, and evaporating lotions applied to
ontrol the inflammatory action liable to follow the manipu-
ations performed. On its subsidence in a few days, another
ttempt may be made, the same precautions being taken.
f the attempts made are without avail, and the functions of
ie joint are so impaired as to render the arm useless, or the
ain, produced by the pressure of the displaced bone upon
ie nerves, unendurable, an operation for the establish-
ent of a false joint by subcutaneous section of the bone,
ould be made in the manner as first suggested, and per-
med by the author in 1875, upon a patient at that time
ler his care.

Excision of the end of the displaced bone may be per-
ied in lieu of subcutaneous section, if the circumstances
e case make it desirable, although it is believed all that
edful can be accomplished by the latter with the great
itage of avoiding the dangers attendant upon the former.
pture of the large artery or vein will be indicated by
dden effusion of blood into the tissues surrounding the
and in case of the artery, cessation of the pulsation in
tal branches.

treatment of arterial rupture consists in making
pressure over the course of the vessel and the appli-
f a ligature, as soon as possible, to the artery above

LOWER JAW—TEMPORO-MA
DOUBLE ARTHRODIA.—This a
glenoid fossa of the temporal b
lower jaw, and is surrounded by
ternal lateral ligaments, with
stylo-maxillary. It has two sy
inter-articular fibro-cartilage. I
eminentia articularis, externally
and behind by the vaginal pro
The movements of the joint ar
slight rotation. The muscles i
the external and internal pteryg
Dislocations of the joint may b
lateral, and *bilateral*. Ruptur
occurs only in the complete form

Causes.—Dislocation may be
lence applied over the joint, cau
It is more frequently the resul
both condyles are dislodged, esc

rule, not torn. The effect of muscular action, in producing luxation, is seen when the mouth is widely opened, the depression of the jaw causing the condyles to advance forwards upon the eminentia articularis. After reaching a certain

Fig. 163.

point, spasmodic action of the fibres of the temporal and masseter muscles occurs, and the processes are thrown into the zygomatic fossa. Depression of the jaw, sufficient to produce dislocation, takes place in yawning, inordinate laughter, the forcible introduction of a foreign body into the mouth, as an apple or billiard ball, or the separation of the jaws for the purpose of the extraction of teeth. I have been informed of a case occurring in this State, in which dislocation happened to a woman, who was, at the time, engaged in scolding her husband, the case resembling that reported by Dr. Dorsey. A case came under my observation, some years since, of a lady who suffered very often from luxation of the jaw in the act of singing, or in making any effort which required wide separation of the jaws. Her husband

was instructed in the method of reduction of the dislocation, and performed the operation for her relief. Dislocation may also occur as the result of indirect force, as in falls or blows upon the chin, the jaw being at the time depressed.

Symptoms.—The symptoms of dislocation of the inferior maxilla are well marked. Pain, in some cases, is quite severe, due to the stretching of the ligaments and muscles involved in the luxation. Loss of function, deformity, and immobility are prominent symptoms. In the complete variety, the wide separation of the jaws interferes with the functions of articulation, mastication, and deglutition. The constant pressure of the rami upon the parotid glands excites them to increased discharge of fluid, and the impaired action of the buccinator muscles permits the free escape of the saliva from the mouth. The depression and projection of the jaw produce marked deformity and give a very unpleasant expression to the face (Fig. 164). The position of the condyle in the zygomatic fossa, combined with the muscular action, fixes the bone and renders it immovable. In unilateral displacement the symptoms are not so well defined, loss of function, deformity, and immobility appearing in a modified degree. In the condition described originally by Sir Astley Cooper as

Fig. 164.

subluxation of the jaw, the condyles glide beyond the position of the articular fibro-cartilages and become fixed upon the eminentia articularis. The symptoms which attend this condition are immobility of the jaw with slight separation of the teeth.

Diagnosis.—Owing to the prominent character of the symptoms attending dislocations of the lower jaw, the diagnosis is not difficult to be made, especially if an examination of the parts occurs soon after the accident. In the normal condition the condyle can be readily felt in its position, and its movement distinguished. When dislocation is present, a depression marks the former prominence, and the displaced condyles can be discovered in the zygomatic fossa. This examination is facilitated by carrying a finger into the mouth, when counter-pressure on the outside being made, both processes, coronoid and condyloid, can be felt in their abnormal positions. Luxation is to be distinguished from fracture of the neck of the condyle by the immobility of the jaw, the absence of crepitus and the abnormal position of the condyle in the zygomatic fossa. In unilateral dislocations the jaw is turned to the side *opposite* the joint affected, and an examination of the mouth shows a want of articulation of the teeth, especially of the anterior. In fracture of the condyloid neck, the jaw is turned *toward* the side injured, and the bone is movable. In a majority of instances, the history of the case will assist materially in determining the nature of the lesion.

Prognosis.—The prognosis is favorable, reduction being effected usually without difficulty and the functions of the articulation being unimpaired. Difficulty is sometimes experienced in accomplishing reduction in cases of long standing, although replacement has been effected at the expiration

of three and four months subsequent to the occurrence of the dislocation. In luxations which remain unreduced, the symptoms gradually disappear, the bone and surrounding ligamentous and muscular structures accommodating themselves to the new conditions, so that the deformity and disability are largely, though not entirely, removed.

Treatment.—The manipulations necessary to obtain reduction consist in drawing the jaw slightly forward, so as to relieve the condyle from its fixed position, elevation of the chin, effecting, by the same movement, depression of the angles, and pushing the bone backward, the condyle, slipping over the eminentia articularis, into its place.

This last movement is usually accomplished by the action of the temporal and masseter muscles, which, when the process is placed upon the eminentia articularis, suddenly contract and throw it into the glenoid fossa.

The surgeon may perform these manipulations in the following manner. The patient being seated upon a low chair, with the head well supported by an assistant, is, if necessary, placed under the influence of an anæsthetic. The surgeon having wrapped the thumbs with thick compresses for protection, stands in front of the patient and introduces them into the mouth, carrying them back to a position between the three molar teeth, and grasps the body of the jaw around the base with the remaining fingers of each hand, extending them backward to the angle (Fig. 165). Having obtained a firm hold of the jaw, it is drawn slightly forward, the chin is elevated, the angles depressed, and condyles pushed back into place or permitted to be drawn back by the muscular action. If the muscles are not too much relaxed by the anæsthetic, the condyles return to their position in the glenoid fossa with an audible snap. The thumbs of the surgeon

should be quickly removed from between the teeth as soon as he recognizes the beginning of the movement of replacement, lest they be caught and injured by the powerful contraction of the muscles.

Fig. 165.

Reduction may be also effected by the introduction of wedges of soft pine wood, between the molar teeth, which, being used as levers, depress the angles of the jaw and permit the condyles to return to place. Corks, secured by pieces of cord, may be used to accomplish the same purpose. The method of M. Nélaton consisted in placing the thumbs on the nape of the neck, the surgeon standing behind the patient, and making pressure on the coronoid processes, through which manipulation the jaw is pushed forward and the angles depressed, so that the condyles can pass over the articular eminence. The late Prof. Gross succeeded in reducing bilateral dislocations, which had resisted other plans of treatment,

by replacing one condyle at a time, in this manner overcoming the muscular tension which existed and defeated previous attempts at reduction.

A fall upon the buttocks, or backward down a flight of stairs, has been known to effect reduction in cases of complete dislocation of the jaw. As methods of treatment, however, they are not to be commended.

Unilateral luxation is reduced in the same manner as those of the bilateral variety. Sub-luxations are easily relieved by drawing the jaw forward and downward. Subcutaneous sections of the temporal, masseter, and external pterygoid muscles may be performed to assist in accomplishing reduction in cases of old luxations which resist the ordinary methods.

After replacement of the displaced condyles, Rhea Barton's bandage should be applied for the purpose of keeping the articulation at rest for ten days to two weeks, the patient meanwhile feeding upon liquid diet.

Patients of feeble constitutions sometimes suffer from an elongated and relaxed condition of the ligaments of the temporo-maxillary articulation, which permit the condyles to slip back suddenly from their position upon the articular eminences, during movements of the jaw, giving rise, in this way, to a crackling noise. Relief is afforded in these cases by the administration of tonics, as iron and quinine, and the repeated application of small blisters over the position of the articulation. Dislocation is liable to occur in these cases, and care should be taken to guard against its occurrence in depression of the jaw, as in the act of yawning.

Instances of congenital dislocation have been reported in connection with this articulation.

VERTEBRAL ARTICULATIONS—AMPHI-ARTHRODIAL.—The vertebral column is a strong, flexuous column, com-

posed of separate segments of bone fastened together by the anterior and posterior common ligaments, with inter-vertebral disks of fibro-cartilage between the bodies, ligamenta subflava between the laminæ, capsular around the articulations and inter-transverse, inter-spinous and supra-spinous between the processes. The peculiar form of articulation between the atlas and occipital bone, and atlas and axis, whereby a greater latitude of movement is permitted, changes somewhat the arrangement of the ligaments and character of the articulation, making the former a double arthrodia and the latter a lateral ginglymoid with a double arthrodia between the articular surfaces. The ligaments of the vertebral column are very strong, and bind the different vertebræ together in such manner as to render their separation impossible without the application of the greatest violence. The portion of the column most liable to suffer from luxation is the cervical, owing to its greater range of movement. Dislocation, not associated with fracture, is extremely rare in the dorsal region, and it is believed that simple dislocation of the lumbar vertebræ never occurs. Dislocation of the vertebræ may be complete and incomplete—unilateral or bilateral—and the direction of the displacement may be forward or backward. In complete luxations, the anterior and posterior common ligaments with the inter-vertebral substances are torn. The anterior common ligament usually escapes rupture, being detached for some distance above and below; the cord may be contused or completely severed and extravasation of blood may occur in the canal. The lodgment of the cord in the vertebral canal, and the great liability to the application of pressure upon it by slight encroachments upon the calibre of the canal, render displacements of the vertebræ very grave accidents.

reason of the interference with the respiratory function of the diaphragm. Pressure in the dorsal and lumbar regions is followed by paralysis involving sometimes the external muscles of respiration, the bladder, rectum, and lower extremities.

Diagnosis.—In dislocations occurring in the cervical region, the symptoms are sometimes sufficiently distinct to free the diagnosis from great difficulty. In other portions of the column they are ordinarily so obscure as to prevent the formation of a positive opinion as to the exact nature of the lesion present.

The symptoms of pain, loss of function, and deformity accompany fractures of the vertebræ as well as dislocations, and are, therefore, not distinctive. Immobility is difficult to distinguish in any region of the column, with the exception, possibly, of the cervical. The detection of a sulcus or depression over the site of the luxation may assist in determining the nature of the accident; it exists, however, in fractures, and I have observed the condition in cases of contusion of the spine, in which the speedy recovery of the patient left no doubt as to the nature of the injury. In dislocation of the upper cervical vertebræ, inspection of the posterior wall of the pharynx may assist in detecting the displacement. In dislocations, the occurrence of paralysis is usually very prompt, while in fractures it may take place at once, as the result of pressure produced by the fragments, or later from pressure exerted by clots or inflammatory deposits. Pressure by clots of blood is not so liable to occur in dislocations as in fractures.

Prognosis.—The prognosis in luxations of the vertebræ is extremely unfavorable, death occurring in a majority of cases immediately or within a short time following the re-

ceipt of the injury. When a fatal result does not occur immediately, the patient may succumb finally to the exhaustion produced by pain, and, possibly, the suppuration occurring from large bed sores. In some cases the function of respiration is seriously involved, by reason of pressure upon the cord in the cervical and lower dorsal regions, which gradually increases, producing a fatal result. Paralysis, more or less complete in character, is liable to follow dislocations of the vertebræ and complicate the case. Instances are recorded of recovery after dislocation, in which the disability has not been very great, and there are still other cases in which reduction has been effected and permanent recovery established.

Treatment.—The great danger of precipitating a fatal termination by sudden compression of the cord in the efforts to effect reduction has contributed largely to the adoption of the expectant plan of treatment in dislocations of the vertebræ. The successful results which have attended the efforts at reduction in cases of luxation in the cervical region, have encouraged surgeons in the opinion that in certain instances in which the nature of the displacement is well-defined, and the symptoms urgent, attempts should be made to accomplish reduction in cases involving this region. In all cases it should be understood that a fatal result may accompany the effort, a result which is otherwise inevitable. If it is decided to attempt reduction, a very careful examination of the parts should be made to obtain, as near as possible, an exact knowledge of the nature of the luxation.

The manipulations necessary to obtain reduction should be carefully considered, and should be made with the utmost caution and precision. The patient should be placed under the influence of an anæsthetic, so as to secure complete re-

laxation of the muscular system, and overcome all resistance. Extension should be slowly and steadily made in the line of the vertebral column, the head being firmly grasped by the hands of the surgeon, placed beneath the occiput and base of the lower jaw. Counter-extension should be made from the shoulders, which are securely fastened to the table, upon which the patient rests by folded sheets crossed in front and behind, or they may be held firmly by two assistants grasping the summits. The operator being on a level with the shoulders may place his feet on the summits and in this manner make counter-extension while extension is being made with his hands. In anterior displacements the head should be drawn cautiously backward so as to unlock the parts, then upward and finally forward, in this manner placing the vertebræ in such position that a return to place will occur. In posterior luxations the manipulations should be the reverse. Pressure and counter-pressure may be employed in combination with extension and may prove of great assistance. Sometimes pressure may be practised successfully by introducing the finger through the mouth into the pharynx, and in this way pushing the displaced bone into place, whilst extension is maintained. In lateral luxations rotation should be made at the same time with extension.

In dislocation of the vertebræ in the dorsal or lumbar region, accompanied by paralysis, the patient should be placed, if possible, upon a water bed, a cheap form of which can be prepared as described on page 130; if this cannot be procured, he should rest upon a firm mattress, and great care should be exercised to prevent the formation of bed sores. Careful attention should be given to the bladder, the catheter being used at least twice in the day, to evacuate its contents. The bowels should be relieved at stated times by ene-

mata, if necessary. When involuntary escape of the urine or feces occurs, measures should be taken to protect the bed by use of the urinal and masses of oakum, in which the feces may be received.

A condition designated as *sub-luxation* of the vertebræ is described as occurring as the result of violence, inflicted over the region involved, most frequently the dorsal, or of force transmitted through a fall upon the buttocks. The effect of the violence is to cause a rupture of the ligaments and separation of the spinous processes. Severe concussion usually accompanies the injury with, sometimes, symptoms of compression of the cord and partial paralysis. The treatment consists in rest in the recumbent position upon a firm mattress, with the administration of remedies internally, and, if needed, local applications to allay inflammatory action.

Hyoid Bone.—In youth, the cornua of this bone are connected to the body by cartilaginous surfaces and held together by ligaments forming an articulation. In middle life, consolidation usually occurs between the body and greater cornua, and in old age all of the segments become united, forming a single bone. Dislocation of the greater cornua can only occur in early life, and instances recorded as having taken place after that period, have been associated probably with abnormal conditions in the articulation, as in one of the cases reported by Dr. Gibb, of London.

Causes.—Luxation of the cornua of the hyoid bone may be the result of external violence, as that applied to the neck by the hand, or of muscular action, the body of the bone being fixed, while the muscles inserted into the upper border of the cornua act with undue violence.

Symptoms.—The symptoms attending dislocation of the cornua of the bone are not very distinct. In one of the

extremity of the rib to the vertebra renders the articulations very strong, and this fact, combined with the protected position occupied by them, makes simple dislocation at this point almost an impossibility. In nine cases of costo-vertebral luxations collected by Mr. Poland and quoted by Prof. Agnew, six were uncomplicated and three accompanied by fracture or other injury. In one case under the care of Prof. Agnew fracture accompanied the dislocation.

COSTO-CHONDRAL JUNCTION.—The junction of the cartilage with the rib cannot be properly described as an articulation; the cartilages are simply continuous with the osseous structures of the ribs, being received in cup-shaped depressions on the end of the rib and covered by an expansion of the periosteal membrane. Dislocation, or rather separation at this junction, is extremely rare, although a number of cases have been observed and recorded. The case related by Sir Charles Bell is most remarkable, in which all of the ribs were separated from their cartilages as the result of violent compression of the thorax.

CHONDRO-STERNAL ARTICULATIONS.—These articulations are arthrodial, and are united by anterior, posterior, and capsular ligaments with synovial membranes between all except the first; the second and third have two each while the remaining have one each. A dislocation occurring at these articulations, although rare, occurs more frequently than those at the costo-vertebral joints. The late Prof. Gross reports having seen several cases of the kind.

CHONDRAL ARTICULATIONS.—The articulations occuring between the cartilages of the sixth, seventh, eighth, and ninth ribs are also arthrodial, and are enveloped by thin capsular ligaments lined by synovial membranes, and strenghened externally and internally by ligamentous fibres. A few instances of luxation of these joints have been reported.

Causes.—The cause of dislocation of the ribs and costal cartilages is external violence, applied directly or indirectly. Direct force, as in falls, blows, or crushes in railroad accidents may produce luxation at either of the joints. Indirect violence, as in severe compression of the thorax, the body being caught between opposing objects, is liable to cause separation at the *costo-chondral* or *costo-sternal* articulations. The force applied in either way must be very severe in character to cause separation at joints so firmly united and protected, and is frequently productive of serious complications in injury to the organs contained within the thorax.

Symptoms.—In costo-vertebral luxations there are no symptoms which can be regarded as distinctive. Pain may be present as in all severe injuries, and pain experienced during the acts of respiration may be the result of muscular contusion or fracture. Symptoms somewhat more prominent attend chondral luxations—as pain, deformity, preternatural mobility, and, in some instances, dyspnœa. Crepitus is sometimes heard over the position of the articulation.

Diagnosis.—To determine the exact nature of the displacement in costo-vertebral dislocation is regarded as impossible, on account of the absence of well defined symptoms, and the position of the parts which interferes with a satisfactory examination. The facility with which the parts can be examined in chondral dislocations and the more prominent character of the symptoms, render the diagnosis less difficult.

Prognosis.—In all forms of dislocations involving the ribs or cartilages, the prognosis is unfavorable, owing to the severe violence accompanying the injury. Costo-vertebral luxations are, as a rule, followed by fatal results, whilst those of the cartilages, if the complications are not too serious, may result in recovery.

Treatment.—Efforts at reduction may be made in dislocation of the cartilages by extending the trunk, and making pressure over the displaced cartilage. Drawing back the shoulders may assist in the attempt. The inhalation of ether will contribute to success in reduction by the expansion of the walls of the chest caused by the deep inspiration taken by the patient. In all varieties of luxation a broad bandage should be firmly applied about the chest to afford support, and limit the extent of the respiratory movements. The conditions resulting from the contusion and other injuries of the parts should be treated upon general principles, the indications being to control by appropriate remedies the inflammatory action liable to supervene. In costo-vertebral luxations the parts should be supported by compresses and a broad bandage, as in fractures, and accompanying complications treated as above indicated.

STERNUM AND ENSIFORM CARTILAGE.—The sternum consists of three pieces, manubrium, gladiolus, and ensiform process or cartilage, united by articulations of the arthrodial variety, which are covered by expansions of the anterior and posterior costo-sternal ligaments. Authorities differ as to the character of the articulation existing between the different portions of the bone. According to Maisonneuve they are fibrous in character in about twenty-five per cent. of cases, and arthrodial in the remaining seventy-five per cent. Dislocation occurs most frequently between the manubrium and gladiolus, rarely between the gladiolus and ensiform process. A number of cases of dislocation between the manubrium and gladiolus have been collected and analyzed by Malgaigne, Mr. Poland, of London, and Dr. Brinton, of this city. Ten by Malgaigne, of which number five died; fourteen by Poland with six deaths, five recoveries, and

three in which the result is unknown; thirteen by Brin with seven deaths and six recoveries. Two cases of lu tion of the ensiform process have been recorded by Malgaig

Cause.—The cause is great violence applied directly, by a blow, or indirectly by extreme flexion of the body, in a crush by the *débris* of a falling wall.

Symptoms.—The most prominent symptom is deformi which is readily seen on examination of the bone. Disloc tions of the ensiform cartilage are accompanied by pain the stomach, dypsnœa, and obstinate vomiting. In luxati of the manubrium the gladiolus is the portion displaced, a passes behind or in front of the manubrium. It takes t former position when the force is applied directly, and t latter when the separation is the result of extreme flexion the body. Pain, dyspnœa, and crepitus heard during resp ration, are also present in most cases.

Diagnosis.—The displacement of the bone is detected inspection, and its position may be determined by examin tion. It is to be distinguished from fracture by fixing t position of the articulation and ascertaining the relation the point, at which displacement occurs, to it.

Prognosis.—The complications which so frequently atte dislocation of the sternum render the prognosis unfavorab In simple cases it may be regarded as favorable, although, many instances, reduction cannot be effected.

Treatment.—Notwithstanding the unsuccessful resu which have accompanied efforts at reduction, they should undertaken in all cases. The patient should be placed his back, bent over a number of hard cushions or pillow so as to extend the body and make the thorax very conv anteriorly. While in this position, pressure should be ma over the displaced bone, so as to force it downward a

backward. When urgent symptoms are present, caused by pressure of the dislocated bone, a small elevator may be introduced subcutaneously into the bone, for the purpose of lifting it into position.

In dislocation of the ensiform process reduction may sometimes be effected by pressing the finger beneath it and raising it into place. In one of the cases reported by Malgaigne, a small incision was made into the abdominal cavity, by the side of the cartilage, and it was then elevated into position with a hook. Whether reduction is effected or not, a broad bandage should be applied around the chest in all varieties of dislocations, and measures should be taken to treat the complications present.

Upper Extremity.

Dislocations of the upper extremity may be divided into those of the shoulder, including the clavicle and scapula, humerus, radius and ulna, carpus, metacarpus, and phalanges.

Shoulder.—The shoulder is formed by the clavicle and scapula united at the acromio-clavicular articulation.

Clavicle.—The clavicle is placed between the manubrium of the sternum and acromion process of the scapula, attached to the former by the ligaments of the sterno-clavicular articulation, and to the latter by those of the acromio-clavicular. Dislocations may occur at either joint, or, in rare instances, at both simultaneously.

Sterno-clavicular Articulation.—This articulation is *arthroidal* in character, and is formed by the sternal end of the clavicle, the upper and lateral surfaces of the first piece of the sternum, and the cartilage of the first rib. The ligaments of the joint are the anterior and posterior sterno-

clavicular, interclavicular, costo-clavicular or rhomboid, and interarticular fibro-cartilage. This joint bears a very important relation to the shoulder, being the centre of its movements, and admits of motion upward, downward, forward, backward, as well as that of circumduction. The end of the clavicle and interarticular fibro-cartilage glide upon the articular surface of the sternum. Dislocations at this articulation are much less frequent in occurrence than at the acromio-clavicular joint, the explanation being found, probably, in the protected position it occupies, and the immunity it enjoys by reason of the manner in which it receives the application of force. Males suffer from the accident more frequently than females. The displacement of the end of the clavicle may be in the *forward*, *backward*, or *upward* direction, and may be *complete* or *incomplete*.

Causes.—In the production of luxation of the sternal end of the clavicle the force may be applied directly or indirectly, causing the *forward*, *backward*, or *upward* displacement.

Dislocation *forward* is the result, usually, of force applied to the shoulder when it is drawn backward, as may occur in falls. The end of the bone is driven outward and through the rupture of the ligaments forward upon the front of the sternum, the interarticular ligament generally accompanying it.

The *backward* displacement may be caused by violence applied directly over the sternal extremity, by which it is forced from its position backward, as when it is the result of blows over the part. Force applied to the shoulder when it is drawn forward is transmitted to the articulation in such manner as to drive the end through the posterior ligaments backward, and then forward to a position somewhat behind the sternum.

Luxation *upward* results usually from violence applied to the top of the shoulder, causing a depression of the scapula downward and inward, and pushing the sternal extremity upward through the ligaments upon the interclavicular notch.

Symptoms.—The symptoms vary in accordance with the character of the displacement. In all varieties, pain, loss of function, and deformity are present.

In the *forward* dislocation, pain is usually not very marked; it is increased on making attempts to move the arm, the function of which is interfered with by reason of the luxation. Deformity is very prominent, and is caused by the displaced end of the clavicle on the anterior surface of the sternum, a deep sulcus at the position of the joint, produced by the separation of the articular surfaces, and a depression of the shoulder. The sternal origin of the sterno-cleido-mastoid muscle is drawn tense and rendered very prominent, and the head of the patient is turned toward the affected side.

The *backward* dislocation presents, in addition to those mentioned above, as belonging to the forward luxation, symptoms which are characteristic of the injury. The head of the bone is lodged behind the sternum, leaving a depression in the situation of the joint. Generally the pressure exerted by the dislocated bone upon the trachea, œsophagus, and bloodvessels in this region of the neck is sufficient to cause considerable dyspnœa, dysphagia, and cerebral congestion. The loss of function is very marked, the movements of the arm being completely lost. The pain is frequently very distressing.

In the *upward* dislocation the displaced bone occupies a position upon the top of the sternum, obliterating partially the interclavicular notch. The shoulder is depressed and

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assistant being placed between the scapulæ of the patient, seated on a stool or chair, while the displaced bone is pressed into position by the surgeon. Another method consists in placing one hand closed into the axilla, while with the other the elbow is grasped, the arm pushed upward against the acromio-clavicular articulation, and the shoulder carried upward, outward, and backward; the forearm is then brought across the chest, the fingers resting upon the opposite clavicle. This movement may be assisted by manipulation, the displaced extremity being pushed slightly upward and backward. Desault's apparatus (Fig. 67) should be now applied to hold the parts in position, a large pad being placed over the articulation to afford pressure and support. In place of this dressing, Fox's apparatus for fractured clavicle (Fig. 107), Velpeau's bandage (Fig. 66), or the plaster dressing (Fig. 113), may be employed. Frequent inspection of the parts should be made to see that the reduction is maintained, and the dressings should remain in position from ten to twelve weeks.

The displacement of the bone in the dislocation *backwara* may be overcome by the same manipulation as that practised in effecting reduction in the forward luxation. The method in which the knee is placed between the scapulæ will probably be most effective. Assistance may be rendered by drawing the arm away from the body at right angles. Recurrence of the displacement may be prevented by the application of the posterior figure-of-8 bandage, a long, thick, compress being placed between the scapulæ. A splint, extending from one shoulder to the other, may be placed over the compress, and the figure-of-8 bandage then applied, as employed by Mr. De Morgan.

In an exceptional case of backward dislocation, which re-

sists all efforts at reduction, and in which the pressure exerted by the displaced bone upon the structures of the neck causes grave symptoms, it may be necessary to resort to the operation of excision of the luxated extremity, as performed by Mr. Davie, of Bungay, in a case where the dislocation was caused by deformity of the spine. In this variety of luxation, the clavicle was forced from its articulation by the gradual advancement forward and depression of the shoulder. The pressure upon the trachea and œsophagus caused great dyspnœa and serious difficulty in deglutition. Reduction being impossible by reason of the deformity of the vertebral column and pathological changes which had occurred in the articulation, excision was performed with the result of relieving the condition at once.

Reduction in the *upward* variety of dislocation is accomplished by drawing the shoulder upward and outward, while the displaced end of the clavicle is pressed into the articular cavity. Retention may be obtained by the application of Desault's or Fox's apparatus, a pad being firmly secured over the articulation by adhesive strips or bandages; a plaster jacket may be advantageously employed. Great difficulty is experienced in retaining the luxated bone in position, and defective repair usually follows treatment.

Acromio-Clavicular Articulation.—This joint is formed between the outer flattened extremity of the clavicle and the upper edge of the acromion process of the scapula, likewise flattened—the articulating surfaces on each being small oval facets; that on the clavicle is directed obliquely downward and inward. The ligaments which serve to unite the clavicle to the acromion and coracoid processes are the superior and inferior acromio-clavicular, the coraco-clavicular (conoid and trapezoid), and interarticular fibro-cartilage.

The ligaments are very strong and fasten the clavicle firmly to the scapula. The form of the articulation permits of a gliding movement of the clavicle on the acromion process and a rotation of the scapula upon the clavicle forward and backward.

Dislocations of the clavicle may occur in three directions —upward above the acromion process, downward and backward beneath it, and downward and forward beneath the coracoid process. Of these different varieties, the first occurs most frequently, owing to the direction of the articular surface upon the clavicle. These displacements may be complete or incomplete. In the complete *upward* dislocation, all, or part of the fibres of the coraco-clavicular ligaments may be torn as well as those of the acromio-clavicular.

Causes.—Severe external violence, applied directly or indirectly, is required to produce luxation at this joint. Direct force may be received upon either the clavicle or scapula, and indirect force may be transmitted from the sternum through the clavicle to the articulation, or from the elbow through the humerus to it. The violence necessary to produce the luxation is usually so great as to inflict injury upon the surrounding structures, causing severe contusions.

Symptoms.—The most characteristic symptom of the different forms of dislocation occurring at this articulation is deformity, varying in accordance with the position taken by the displaced bone. Loss of function, affecting the arm, is more marked in the upward and backward than in the forward displacement. Pain, discoloration, with more or less swelling, accompany all varieties of the luxation.

In the *upward* dislocation, a small, hard tumor is seen and felt over the acromion process, which disappears on elevation of the arm and returns when the limb is depressed.

The head is turned towards the injured shoulder, and the arm rests against the body, the patient being unable to carry the hand to the mouth.

The *downward* luxation is characterized by a very marked prominence of the acromion process, and at the same time an inward projection toward the sternum. The disability of the arm is shown in the inability of the patient to execute voluntary movements with it.

In the *forward* dislocation, the position of the clavicle beneath the coracoid process renders both this process and the acromion very prominent, and at the same time the sternal end of the clavicle is tilted up—the scapula is inclined downward and forward; the movements of the arm are free, except in the upward and inward direction.

Diagnosis.—The symptoms in each variety of dislocation are so distinct that no difficulty is encountered in making the diagnosis. When inspection does not reveal the position of the displaced bone, the finger can be passed over its border, tracing it to the abnormal position occupied. Examination through the axillary space will assist in discerning the displaced bone in the dislocation forward, under the coracoid process.

Prognosis.—Owing to the peculiar formation of the acromio-clavicular articulation and the almost complete laceration of the ligaments in dislocation, the prognosis as to permanent restoration of the displaced bone is unfavorable; as stated by the late Prof. Gross, it is fortunately a matter simply of deformity and not of utility, as the functions of the parts involved are in a great measure gradually restored.

Treatment.—The reduction in the different forms of acromio-clavicular luxation is to be effected in the same manner

as in those of the sterno-clavicular articulation. In the *upward* dislocation the displaced bone can be readily returned to its normal position by drawing the shoulders upward and backward, the movement being accomplished by placing the knee between the scapulæ and grasping the shoulders with the hands, while the patient is seated upon a chair. Retention may be obtained by placing a piece of sheet-lead, enveloped in the folds of a thick compress, over the articulation, and securing it in place, as well as fixing the position of the arm by the application of the spica bandage of the shoulder (Fig. 52), or Desault's or Velpeau's bandage. Additional support may be given to the lead compress by passing a broad strap over it, and then carrying this under the elbow and securing it by another strap around the chest. The tourniquet of Petit may be applied in the same manner as suggested by Laugier.

The *downward* luxation may be reduced in the manner described above, the elbow being carried across the chest to relax the muscles acting upon the shoulder. The displaced bone may be retained in place by dressings, which will keep the shoulder outward and upward by affording support to the arm as Velpeau's bandage.

Reduction of the *forward* dislocation is obtained by an assistant who flexes the arm, and, having drawn it to the side of the body, forces it upward, outward, and backward, the surgeon meanwhile taking hold of the clavicle, dislodges it from its position beneath the coracoid process, and returns it to its place.

In view of the difficulties encountered in securing satisfactory results after sterno-clavicular and acromio-clavicular dislocations by the dressings employed, the late Prof. Gross suggested the introduction subcutaneously of silver wire

sutures, for the purpose of uniting the articular extremities, permitting them to remain, if not permanently, until firm reunion is established. Successful cases have been reported in which this plan of treatment has been adopted.

A number of instances of double dislocation of the clavicle have been reported, the result of falls upon the upper and back part of the shoulders. Reduction may be effected by drawing the shoulders back and pressing the luxated ends into position with the fingers. Compresses should be placed over the affected articulations and held by posterior figure-of-8 and spica bandages of the shoulders. Desault's or Velpeau's bandages may be also employed.

SCAPULA.—Systematic writers describe the displacement arising from the separation or elongation of the fibres of the latissimus dorsi muscle at their point of attachment to the inferior angle of the scapula as dislocation of the scapula. As no articulation exists at this point, it seems scarcely proper to classify it with luxations of this bone. The displacement occurs most frequently in girls and boys of feeble constitution. The angle being freed from its attachment, rides over the border of the muscles and forms a marked prominence in the dorsal region. Detachment of the muscular fibres may result from violence, as in a fall or by a blow over the part. Efforts should be made by manipulation to replace the angle beneath the muscle, and then to secure it by a compress and broad bandage carried around the chest, the arm being supported in the Velpeau position.

Where the displacement occurs in anæmic children, tonics should be administered, and measures should be adopted to improve the general health; a broad bandage should be worn about the chest, or suitable braces to throw the shoulders back.

HUMERUS — SHOULDER-JOINT — ENARTHRODIAL OR BALL AND SOCKET ARTICULATION.—The bones entering into the formation of this joint are the scapula, which receives the large globular head of the humerus into the shallow glenoid cavity occupying its head. The ligaments of the joint are the capsular, a large, loose fibrous membrane which entirely envelops the articulation, the coraco-humeral, a reinforcing ligament, a broad band extending from the coracoid process across the capsular ligament to the greater tuberosity, and the glenoid, a fibrous band attached around the margin of the glenoid cavity to deepen it.

The shallow glenoid fossa, with the globular head of the humerus, forming a large articulating surface, inclosed in the ample capsular ligament, permits extensive movements in this joint—movement in the forward and backward direction, abduction, adduction, circumduction, and rotation. The construction of the joint, while it allows so much freedom in movement, exposes it to the ready occurrence of dislocation, and as a result, this accident affects this articulation more frequently than any other of the body. Luxation takes place oftener in males than in females, owing to the modes of life of the former. Dislocations of this joint rarely occur before fifteen or after sixty years of age.

Varieties of Dislocation.—The various forms of dislocation described in connection with the shoulder-joint, may be, with propriety, reduced to four. The displacement takes place in three directions, and produces the downward, *subglenoid* or *axillary*; the forward, *subcoracoid*, *thoracic* or *subclavicular*, and the backward, *subspinous* dislocation. In the *subglenoid* or *axillary* luxation, the head of the humerus is placed in the axilla, below the margin of the

glenoid cavity (Fig. 166), in the *subcoracoid*, it occupies a position a little below and to the inner side of the coracoid process (Fig. 167); in the *subclavicular* or *thoracic*, below

Fig. 166.

Fig. 167.

the clavicle, at the junction of the anterior, with the external surface of the chest (Fig. 168); in the *sub-spinous*, on the dorsum of the scapula, below the spine (Fig. 169). Of the various forms the subcoracoid occurs most frequently. Instances of anomalous dislocations have been, from time to time, recorded as the *supracoracoid*, in which the head of the humerus has been placed above the coracoid process, as in cases reported by Malgaigne and Mr. Holmes; the *subscapular*, where the bone occupied the sub-

scapular fossa, in the case described by Dr. Willard Parker. The late Professor Gross had in his cabinet a specimen illustrating what may be designated as the *supraclavicular* variety, the displaced head of the bone being "lodged under

Fig. 168.

Fig. 169.

cover of, and partly above the clavicle." An extremely rare form of luxation has been described by Larrey, from a preparation, in which the displaced bone had penetrated the cavity of the chest through the third intercostal space.

In the complete form of dislocation, the head of the bone escapes through a rent in the capsular ligament, more or less extensive, in accordance with the force applied in producing the luxation. The soft structures surrounding the joint are also frequently lacerated and contused. In persons suffering from constitutional debility or paralysis, the ligamentous and muscular structures surrounding the joint may be so relaxed as to permit luxation without laceration of the capsule.

Causes.—Dislocations of the shoulder-joint may be caused by external violence or muscular action. External violence may be applied directly upon the anterior, superior, or posterior surface of the articulation, forcing the head of the bone *backward*, *downward*, or *forward*, producing displacement in these directions. Force applied indirectly, as in falls upon the hand or elbow, may produce displacement in the same directions, the arm being at the time drawn backward, extended, or drawn forward. The effect of muscular action in causing luxation has been observed in the violent and spasmodic contractions occurring in epilectic convulsions; also in extreme extension of the arm, the head of the bone being in a favorable position to be acted upon by sudden contraction of the muscles. Professor Gross quotes a case reported by Dr. Garrison, of Illinois, in which luxation occurred in a fit of sneezing.

Symptoms.—While the usual symptoms of dislocation, pain, loss of function, deformity, and immobility characterize all luxations of the joint, each have certain symptoms which distinguish them.

In the *subglenoid* or *axillary* variety the complete removal of the head of the bone from the glenoid cavity and its position in the axilla, renders the acromion process very prominent, flattens the shoulder, leaves a depression below the process, which can be distinctly felt, and increases the height of the axillary space. Through the action of the deltoid and biceps muscles, the elbow is projected from the body and the arm is flexed. The limb is lengthened. Pressure upon the nerves and bloodvessels of the axilla causes numbness in the forearm and hand, and impairment in the force of the arterial pulse. The capsular ligament is torn at its inferior part, and the displaced bone lies between the long

head of the triceps and subscapular muscles, in this position rendering unduly tense the deltoid, supra-spinatus, and both heads of the biceps. The patient is unable to place the hand of the injured arm on the sound shoulder.

The symptoms of the *subcoracoid* dislocation are similar to those of the *subglenoid*. The position of the head of the bone beneath the coracoid process gives prominence to the acromion process, and leaves a depression beneath it into which the fingers can be placed (Fig. 170). The head of the

Fig. 170.

displaced bone can be felt in its abnormal position, and the functions of the arm are markedly impaired. The arm is projected backward beyond the middle line of the side of the body, the elbow abducted and the forearm flexed on the arm. The patient cannot grasp the shoulder of the sound side with the hand of the luxated arm. The limb is but little increased in length, if at all, shortening being sometimes present. The vessels and nerves of the axillary space sometimes escape pressure, or, at least, less compression is exerted

upon them than in the subglenoid dislocation. As a rule, the compression is very great, and the pain and numbness in the arm and fingers are very marked.

In the *subclavicular* or *thoracic* luxation the head of the humerus rests upon the anterior lateral surface of the chest, between the second and third ribs, and beneath the pectoralis major and minor muscles. The symptoms are the same as those of the subcoracoid variety increased somewhat in degree. The great displacement forward of the bone renders the deltoid muscle very tense, and gives marked prominence to the acromion process. The elbow is projected to a greater distance from the side of the body, and is directed further backward. Severe compression may be made upon the vasculo-nervous cord of the axilla, and, as a result, the pain may be very great. The fixed position of the limb produces great impairment of function. The head of the bone may be seen and felt in its position beneath the lower border of the clavicle. The arm in this variety of dislocation is shortened.

The symptoms of the *subspinous* form of dislocation are very characteristic. The displacement backward of the head of the bone stretches the clavicular fibres of the deltoid, and gives decided prominence to the acromion and coracoid processes. The bone is placed in its abnormal position, upon the neck of the scapula, beneath the border and inferior surface of the spine, just behind the angle of the acromion process. The limb is advanced beyond the line of the body, and crosses the chest in an oblique direction; it is much shortened, and the forearm is rotated inwards, placing the hand in a state of pronation. The arm is fixed in its abnormal position, and any attempt to move it subjects the patient to pain. In this variety the patient can place the

hand of the injured limb on the opposite shoulder, a movement which cannot be accomplished in any of the three forms of dislocation above described. The head of the bone can be felt beneath the spine of the scapula. The rent in the capsular ligament is usually very extensive, and the muscles are lacerated and contused, producing ecchymosis and swelling.

It will be observed that the prominent symptoms of the various forms of dislocation of the shoulder-joint relate to the configuration of the shoulder, affected as it is by the different displacements of the humerus, the position of the arm and elbow with regard to the body, the function of the limb, especially as far as relates to the ability of the patient to place the hand upon the opposite shoulder, and compression of the vessels and nerves by the displaced bone.

Diagnosis.—In making the diagnosis in dislocations of the shoulder-joint, it is necessary to distinguish the various forms, one from the other, and also from certain conditions which simulate them. A careful study of the characteristic features of each dislocation will enable the surgeon to recognize them in his examination of the part. They may be tabulated as follows:—

be placed in the position which will cause their relaxation and release the bone, while their subsequent individual or combined normal action will assist in restoring it to its place.

In the various forms of shoulder-joint luxations, the different muscles, which act upon the upper extremity of the humerus, are involved in accordance with the character of the displacement.

In the downward dislocation, subglenoid, the *deltoid* and *supra-spinatus* muscles are rendered abnormally tense, and fix the head of the bone in its displaced position against the lower border of the glenoid fossa. The long tendon of the biceps muscle is, as can be readily seen on examination

Fig. 171.

of the articulation, abnormally stretched in all forms of scapulo-humeral dislocations. In effecting reduction by manipulation in this variety, it is necessary to relax the tendon of the biceps, the deltoid, and supra-spinatus, by

flexing the forearm and elevating the limb to a position along the side of the head and then supinating the forearm. In this position the head of the humerus can be felt in the axilla, and should be supported by the fingers of the surgeon, the thumb resting on the top of the shoulder. (Fig. 171.) The limb should now be depressed to the side of the body, the head of the bone being lifted into the socket as the arm is brought to a right angle with the chest.

In the forward dislocation, subcoracoid and subclavicular, the *infraspinatus* and *teres minor* muscles are concerned with the long tendon of the *biceps*, the *deltoid*, and *supra-spinatus* in holding the head of the bone in its abnormal situation. The manipulation necessary to secure reduction is the same as that practised in the subglenoid variety with the addition of *external rotation* after elevation of the arm, in order to relax the supra- and infra-spinati and teres minor muscles.

The posterior dislocation, subspinous, places upon the stretch the *clavicular fibres* of the *deltoid*, the *supraspinatus*, the *teres major*, *pectoralis major*, and *subscapularis* muscles. The relaxation of these muscles is accomplished, and reduction is effected, by elevating the limb to its fullest extent, rotating it *inward* to relieve the tension of the subscapularis, and pushing the head of the bone forward into the glenoid cavity as the arm is carried down to the side of the body.

Prof. H. H. Smith introduced, some years since, the following method of reduction by manipulation. Forward and backward displacements were converted into the downward or subglenoid form as a preliminary step. The forward being changed to the downward luxation by simply elevating the elbow and carrying it to the head of the patient, the arm

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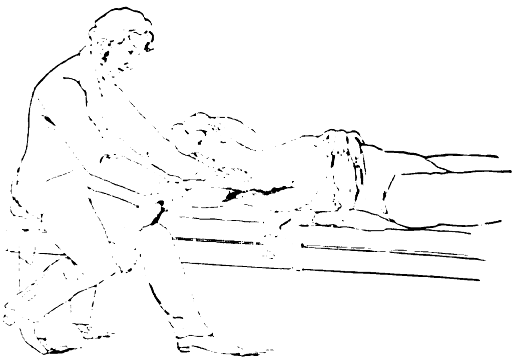
plan is that known as Sir Astley Cooper's, in which extension is made by the surgeon grasping the arm of the patient, counter-extension being made by placing the foot in the axilla. The patient is placed in the recumbent position upon a low bed, table, or on the floor. Extending bands, made with a towel or sheet, are fastened to the arm above the elbow and the limb flexed at a right angle. A towel is placed in the axilla to protect it, and the surgeon, sitting upon the bed with one foot upon the floor, places the other, divested of the shoe, against the compress in the axilla. Steady and continuous traction is now made by means of the extending bands, which, if necessary, may be passed around the shoulders of the surgeon, the limb being gradually carried forward across the body. (Fig. 172.)

Reduction may be also effected by placing the knee in the axilla, the patient being seated in a chair and the foot of the surgeon resting upon it or a stool placed near by. The arm is grasped with one hand, while the other is placed on the top of the shoulder, and the limb is bent over the knee, the head of the bone being, by this movement, raised into its socket. (Fig. 173.)

Another plan in which reduction is effected by extension and counter-extension is that usually described as La Mothe's. According to this method the patient is placed in the recumbent position upon a table, and the surgeon, standing at his head, grasps the arm above the elbow with one hand, while the other is placed upon the top of the shoulder, so as to make counter-extension. (Fig. 174.) Extension being made, the bone will usually return to its place. Increased power may be gained by putting the foot on the top of the shoulder, and assistance will be rendered by rotating the limb and carrying it from the body while extension is made.

Fig. 173.

Fig. 174.



The displaced bone may be reduced by making extension and counter-extension, by placing the foot on the posterior fold of the axilla, so as to steady the scapula, and making traction with the arm at right angles to the body. The effort is completed by bringing the arm to the side of the body so as to direct the bone into the articulating cavity.

This plan of extension is somewhat modified in the method of Dr. Logan, of New Orleans, the surgeon grasping the shoulder between the feet and traction being made with the arm at right angles to the body. In executing this manœuvre, the heel of one foot is placed in the axilla, against the ribs, so as to press somewhat obliquely, and the base of the great toe of the other foot rests against the acromion process. In both of the methods, in which the extension is made at right angles to the body, the movement is best accomplished when the patient is in the recumbent position on the floor.

The method of Dr. Nathan Smith in making extension and counter-extension with the arm at right angles to the body is seen in Fig. 175. The sound arm being carried from the body at right angles, a counter-extending band, made from a folded sheet, is placed around the chest, the ends passing in front and behind the chest and arm, and is secured at the wrist by a circular band. The extending band is fastened by figure-of 8 turns to the wrist and hand of the injured arm, while a third band passing over the top of the shoulder is secured to the chair. The surgeon, with the foot upon the chair, places the knee in the axilla and as extension and counter-extension are made, lifts the bone into place.

If reduction cannot be obtained by the methods above described an effort may be made to accomplish it by means of the compound pulleys. They should be employed with

Fig. 175.

great care lest serious injury be inflicted upon the structures of the joint. They may be applied in the manner represented in Fig. 176, the patient being seated in a chair, and counter-extension being made by a band with an opening in it through which the injured arm is passed.

It is desirable, in all cases of luxation of this joint, to make efforts at reduction, while the patient is under the influence of an anæsthetic, so as to secure complete relaxation

of the muscles involved in the dislocation and avoid resistance on the part of the patient.

Fig. 176.

After reduction, the arm should be supported in the Velpeau or Desault bandage for a period of ten days or two weeks and then for a similar period carried in a sling. Rigidity of the parts may be removed by frictions with stimulating liniments and careful passive movements. In obstinate cases the rigid tendons and muscles may be divided subcutaneously. If much contusion has been received at the time of the accident, the pain and swelling may be relieved by enveloping the parts in compresses wet in a solution of laudanum and lead-water.

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filtration of blood into the tissues, prompt ligation of both ends of the torn artery is the proper treatment. Where laceration of the inner coats of the artery occur forming diffused aneurism, ligation of the subclavian artery should be performed. In one case, reported by Bérard, in which pulsation of the radical artery ceased after subcoracoid luxation, gangrene attacked several of the fingers and death subsequently occurred. Laceration of the axillary vein should be treated by pressure with compresses and a roller firmly applied.

Double dislocations of the shoulder-joint, which occur rarely, are the result of falls, the patient extending both hands to avoid injury. The displacement may be the same in both joints or may vary. Fracture of the scapula, clavicle, or humerus frequently accompanies this form of luxation. The late Prof. Gross observed two cases of simultaneous dislocation; one occurring in his own practice, both having taken place during an attack of epileptic convulsions. Dr. Nathan Smith reported a case occurring in an attack of puerperal convulsions. The treatment of double luxations is to be conducted in the same manner as that in single displacements.

Old Dislocations.—The pathological changes which take place in old unreduced dislocations have been freely discussed on page 317. The question of interference in these cases is a very important one, and requires serious consideration on the part of the surgeon. While there are a number of instances on record in which successful efforts at reduction have been made at the expiration of several months, there are also records of cases in which very serious accidents and fatal results have followed efforts at reduction at much less period of time, and hence there can be no general rule laid down for guidance in these cases. The conditions which

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tion of a dislocation of six weeks' standing by this plan, Prof. Agnew ruptured the axillary vein in a woman sixty years old, who recovered under the use of sorbefacient lotions and firm bandaging. Dr. Willard, of this city, has collected and analyzed nineteen cases of rupture of the axillary artery following efforts at reduction in old dislocations of the shoulder-joint. Of these, twelve died, six recovered, and in one the result was unknown. In three of these cases the axillary artery was ligated without benefit; in four the subclavian, with two successful results. Rupture of both artery and vein occurred in three cases, two of which terminated fatally—the result in the other was not stated. As stated above, ligation of the artery should be performed in all cases of rupture. Contusion, rather than laceration, of the *axillary nerves* is liable to follow efforts at reduction in old dislocations of this joint. Impaired function, with pain and swelling of the limb, occurs. When rupture of any of the principal nerves takes place, paralysis of the parts supplied by the nerve follows the accident. In these cases, the arm should be confined in Desault's or Velpeau's dressing until repair of the injury has occurred, massage and friction being then instituted to assist in restoring the impaired function.

Fractures of the humerus occurring in connection with attempts at reduction should be treated upon general principles. Mr. Teevan, of London, has reported a case of fracture of the ribs following pressure in the axilla during efforts at reduction.

The inflammation which follows the separation of the adhesions in old dislocations is sometimes of a very severe character, and may result in the formation of a diffused abscess, endangering the life of the patient.

Cases have been reported in which death has followed as the result of *shock*.

Considering the dangers which attend efforts at reduction in old dislocations of the shoulder-joint, the following propositions may be stated for guidance in their employment.

1. In view of the varying conditions which attend old luxations of the shoulder-joint in different individuals, the rule applied by Sir Astley Cooper, fixing three months, after the receipt of the injury, as the limit beyond which any efforts at reduction should be regarded as injudicious, except in persons of very lax fibre or advanced age, may be accepted as a guide.

2. Interference should be avoided in those cases in which free movements of the limb indicate the formation of a new joint, and the establishment of such relations of the surrounding structures to it by inflammatory action as to render manipulative efforts dangerous.

3. The occurrence of severe inflammation after the receipt of the injury, indicating, as a result, the consolidation of the structures by plastic deposits, and the formation of extensive adhesions between the displaced bone and the structures, may be accepted as a contra-indication to the adoption of efforts at reduction.

4. Interference should be avoided in those cases in which the function of the limb is not very greatly impaired, and in which some doubt may exist as to the re-establishment of more perfect movements after reduction. In connection with this proposition, the question of the risks assumed in making the attempts at reduction should be considered.

5. Interference is justifiable in cases in which there is great impairment of function or constant and excessive pain due to pressure of the displaced head of the humerus upon

the brachial plexus of nerves. In such cases, the formation of a false joint, by subcutaneous section through the surgical neck of the bone, or excision of the head of the bone, is the proper method of treatment to be pursued.

6. In all cases in which efforts at reduction are undertaken, preliminary treatment should be instituted to place the patient and the parts in the best condition. The difficulties and dangers attending the procedure should be clearly explained to the patient, in order that the surgeon, in the proper performance of his duty, may not be held responsible for accidents beyond his control.

Congenital Dislocations.—Instances of congenital dislocations of the shoulder-joint have been recorded and carefully studied by Mr. R. W. Smith in his work on Fractures, Gaillard, as quoted by Malgaigne, Guérin, Nélaton, and others. Two varieties, the *subcoracoid* and *subacromial*, have been described. Among the symptoms presented in these cases is atrophy of the arm, with normal development of the forearm. The other symptoms are the same as those accompanying ordinary traumatic dislocations. The changes present in the articulation in these cases, consequent upon defective development, render their treatment usually unsuccessful. When attempted, it should be conducted according to the methods employed in luxations generally.

Dislocation of the shoulder-joint occurs sometimes as the result of traction made upon the arm during parturition. Prof. Agnew states "it is not improbable that such may have been the origin of some of the cases recorded as congenital dislocations."

Dislocation of the tendon of the biceps muscle is reported as having occurred independent of luxation of the humerus. In connection with dislocation of the humerus it may be

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RADIUS AND ULNA—ELBOW-JO
TICULATION.—The bones entering
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The muscles in relation with the articulation are the biceps and brachialis anticus in front, the triceps and anconeus behind, the supinator longus and brevis, with the common tendon of origin of the extensor muscles of the forearm externally, and the common tendon of origin of the flexor muscles internally. Those which are chiefly concerned in the displacements, which occur in dislocations of the joint, are the triceps, biceps, brachialis anticus, and supinators. The brachial artery and median nerve occupy important relations in front of the joint, with the musculo-spiral nerve externally and the ulnar in the groove upon the back of the inner condyle of the humerus.

Dislocations of the elbow-joint occur most frequently in early life, Hospital statistics showing that the majority take place under fifteen years of age, the average, in a number, being about twenty years. The accident is rare after forty-five years—as with luxations of the shoulder-joint it occurs more frequently in males than in females.

Dislocations of the articulation may be divided into those of the *humerus*, *radius* and *ulna*, of the *humerus* and *ulna*, and of the *humerus* and both *radius* and *ulna*, commonly described as *dislocation of the elbow-joint.*

HUMERUS, RADIUS AND ULNAR—SUPERIOR RADIO-ULNAR ARTICULATION—LATERAL GINGLYMOID.—This joint is formed by the inner side of the circumference of the head of the radius, and lesser sigmoid cavity of the ulna in which it rotates. The radius is held in place by the orbicular ligament which surrounds its neck, and the joint is lined by an expansion of the synovial membrane of the elbow-joint. The movement of the articulation is confined to rotation of the head of the radius, within the orbicular ligament. The proximity of this articulation to that of the elbow and the

relation held by the radius to both, makes it important that their construction and movements should be studied in conjunction. The explanation of the great difficulties which attend reduction in dislocations of the elbow-joint, after the lapse of a short period of time, may be found, I believe, in the relation assumed by the structures entering into the formation of both articulations, on account of the independent movement of the radius.

In the complete forms of dislocation of the humerus, radius, and ulna, the anterior, external lateral, and posterior ligaments, with the orbicular, are torn and the radius is separated from the lesser sigmoid cavity of the ulna and from the radial head of the humerus, and placed in *front* of, *behind*, or *external* to the external condyle of the humerus, forming a dislocation *forward*, *backward*, and *outward*.

Causes.—The cause of *radio-ulnar-humeral* dislocations is external violence, applied either directly or indirectly. It is applied most frequently in the indirect manner, as in falls upon the hand, the forearm being at the time in a state of extreme pronation.

In the *forward* luxation the displacement may occur as the result of blows or kicks upon the posterior surface of the upper extremity of the radius, of severe wrenches or twists of the forearm, or of falls upon the hand.

Backward dislocation may be produced by direct force applied to the anterior surface of the head of the radius, by extreme forcible pronation of the hand, or by falls upon the hand, the forearm being in a state of pronation and carried away from the body. Fracture of the condyle of the humerus frequently accompanies this form of luxation.

The *outward* dislocation, in the complete variety, is the result of extreme violence indirectly applied, through falls

upon the hand. In order to place the head of the radius upon the external surface of the condyle, the ulna retaining its position, a laceration of the oblique and interosseous ligaments must occur. The violence necessary to accomplish this would be liable to produce, at the same time, fracture of the ulna or humerus and, as well, inflict great injury upon the soft structures.

Symptoms.—The symptoms of the various forms of displacement are usually characteristic, the different positions assumed by the head of the radius giving a distinctive character to the deformity. The pain is caused rather by the injury inflicted upon the soft structures at the time of the accident, than by the implication of any of the large nerves in relation with the joint or the muscular tension due to the displacement. The function of the joint is abridged, not totally lost in any form.

In the *forward* dislocation, the position of the head of the bone upon the anterior surface of the condyle (Fig. 177)

Fig. 177.

shortens the radial side and rotates it outward. Flexion of the forearm at a right angle is prevented by the brachialis muscle which holds the radius in contact with the anterior

surface of the humerus, thus interfering with its further displacement upward. Extension cannot be completely obtained owing to the position of the head of the radius, which can be felt rotating beneath the finger, when efforts at supination and pronation are made. The biceps and supinator brevis muscles are relaxed and the forearm is usually partially flexed, and in a position of slight pronation or midway between supination and pronation. The lesser sigmoid cavity of the ulna, made vacant by the displacement of the bone, can be felt as a depression below the external condyle of the humerus.

In the *backward* luxation, the loss of function is very marked, the limb being semi-flexed, and in a fixed state of pronation. The movements of extension, flexion, and supination cannot be executed without the employment of much force. The biceps muscle is tense, its tendon being felt beneath the skin. The depression caused by the unoccupied

Fig. 178.

sigmoid cavity cannot usually be distinctly outlined, owing to the position of the bone. The displaced head of the radius can be felt in its fixed position on the posterior surface of the condyle (Fig. 178), by the side of the olecranon process. The fingers are usually somewhat bent.

The *outward* luxation is characterized, in the complete variety, by marked deformity, caused by the position of the head of the radius upon the outer surface of the external condyle. The function of the limb is very much impaired, flexion and extension being restricted, and the movement of supination abolished or executed with great difficulty. The arm is placed midway between pronation and supination, with marked prominence of the radial border of the forearm.

Diagnosis.—The symptoms in the different varieties of dislocation of the humerus and radius are sufficiently distinctive to render the diagnosis easy after careful examination and study. The prominence afforded by the displaced bone, in the different positions occupied, will enable the surgeon to distinguish it. If the movements of pronation and supination are executed, the rotation of the head can be readily felt.

Prognosis.—The difficulty of effecting reduction and retention in the *forward* dislocation makes the prognosis in this variety doubtful. In unreduced luxations the functions of the joint are not materially impaired, the movements of extension, pronation, and supination being well performed while that of flexion gradually improves.

In the *backward* and *outward* luxations the prognosis may be regarded as favorable.

Treatment.—Reduction may be effected in the *forward* luxation by flexing the arm to increase the relaxation of the biceps muscle and then making extension from the hand, counter-extension being accomplished by an assistant who grasps the arm. Whilst extension is being made, the surgeon should press the head of the radius downward and outward, the forearm being placed at the same time in a state of supination.

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the humerus occurs very infrequently. The displacement is usually *backward*, the coronoid process resting in the olecranon fossa of the humerus or behind the internal condyle (Fig. 179). In this displacement the orbicular, as well as the oblique ligament and interosseous membrane will be ruptured. In the complete variety the coronoid process is usually fractured.

Fig. 179.

Causes.—The dislocation is the result of severe violence applied indirectly, as in falls upon the inner and upper part of the hand, the force being transmitted in the line of the ulna while the arm is in such position of flexion as to favor the separation of the bone from the trochlear surface of the humerus.

Symptoms.—The symptoms are very characteristic, the forearm and hand being flexed and the limbs presenting a twisted appearance. The function of the arm is very much impaired, both flexion and extension, especially the latter, being restricted and painful. The olecranon process can be distinctly felt in its abnormal position. If fracture of the coronoid process has occurred, the displacement backward and upward of the olecranon process will be greater and as a result the deformity will be increased. The head of the radius is usually slightly displaced from its articulating surface.

Diagnosis.—The prominence formed by the displaced

olecranon process is so distinctive of this dislocation that little or no difficulty should be experienced in arriving at a correct conclusion with regard to the nature of the injury. Associated with the prominent projection of the process, is the twisted appearance of the limb which is characteristic of the luxation.

Prognosis.—The prognosis in dislocation of the ulna is favorable, both with regard to reduction and the restoration of the function of the limb.

Treatment.—The return of the displaced bone to its place may be readily accomplished by placing the knee in the bend of the elbow and making extension by grasping the hand and wrist or forearm. If difficulty is experienced, pressure may be made on the process to assist in effecting reduction. The arm should be secured to an anterior or posterior angular splint, of slight angle, by bandages, and maintained in this position for two weeks. If fracture of the coronoid process is associated with the dislocation, the arm should be placed in a posterior rectangular case, made of felt or tin, and a compress placed over the position of the coronoid process, the whole being held in place by a roller.

Radius and Ulna—Elbow Joint.—The dislocation of both bones of the forearm at the elbow-joint is usually desig-

Fig. 180.

nated *dislocation of the elbow*. The displacement may occur in the *backward*, *forward*, *outward* and *inward* direction.

In the *backward* dislocation, both bones of the forearm leave the articulating surfaces of the humerus and take a position posterior to the lower extremity of the bone, the coronoid process of the ulna occupying the olecranon fossa and the head of the radius resting in contact with the posterior surface of the external condyle. (Fig. 180).

Fig. 181.

In the *forward* luxation, which, as an uncomplicated lesion, is extremely rare, the position of the bones of the forearm is reversed, the head of the radius being placed in front of the external condyle and the olecranon process over the coronoid fossa. In the incomplete variety, the upper surface of the olecranon process is placed over the coronoid fossa, the radius having no point of contact. (Fig. 181.)

The *lateral* displacements of the bones of the forearm are, as a rule, incomplete, the articulating surfaces being rarely entirely separated.

In the *outward* dislocation the head of the radius slips beyond the border of the external condyle, dragging the olecranon process with it, but not separating it completely from the trochlear surface. (Fig. 182.)

The olecranon process, in the *inward* luxation, leaves the trochlear surface and embraces the internal condyle, while

the head of the radius rests in contact with the lower border of the trochlear surface. (Fig. 183.)

Causes.—The dislocations of the elbow-joint, in the various directions described, are caused by severe violence ap-

Fig. 182.

Fig. 183.

plied directly or indirectly. The effect of the application of direct violence is seen in falls upon the point of the elbow, the arm being in a state of extreme flexion; as the result of the impact of force, the *forward* variety of displacement may be produced.

Lateral displacements either *outward* or *inward* may occur also as the result of direct violence, as when the arm is

caught in the spokes of a wheel in motion, or by a rapidly revolving belt attached to machinery. Falls from a height upon the hand, the arm being at the time in a position favorable to permit separation of the articulating surfaces of the bones of the elbow-joint, may produce the *backward* dislocation.

Symptoms.—The symptoms in the various forms of dislocation of the elbow-joint are very prominent. They are characterized usually by great pain, increased upon efforts at movement, marked deformity and immobility. Loss of function is also present, the movements of the limb being very much abridged, if not entirely annulled. The position of the displaced bones in each variety of dislocation affords a distinguishing symptom by which it may be recognized.

Fig. 184.

In the luxation *backward* the anterior and lateral ligaments are ruptured and the brachialis muscle, with the ten-

don of the biceps, made tense as they pass over the end of the humerus. The triceps muscle may be readily grasped at its point of insertion into the olecranon process, and it is either tense or relaxed, according to the position of the arm, whether flexed or extended. (Fig. 180.) The median and ulnar nerves may be subjected to pressure between the posterior and lower surface of the end of the humerus and the bones of the forearm. Great swelling usually attends the injury and contributes to the deformity, which is usually very great. The distance between the wrist and elbow-joints is diminished on the anterior surface, and the arm is twisted and flexed, the forearm being either in a state of slight pronation or in that midway between supination and pronation. (Fig. 184.) The function of the arm is much impaired, flexion and extension being materially restricted and much pain being caused on making attempts to effect movement. If the part is examined before much swelling has supervened the displaced olecranon process can be readily felt in its position behind the humerus where it forms a marked prominence. A projection somewhat more prominent, can be outlined on the anterior surface of the forearm, caused by the lower extremity of the humerus.

The complete *forward* dislocation is accompanied by rupture of all of the ligaments of the joint, with more or less contusion and laceration of the surrounding soft structures. The triceps muscle is rendered unduly tense and in close contact with the end of the humerus, while the biceps and trachealis anticus are much relaxed. The distance between the wrist and elbow-joint is decreased on the posterior surface, the forearm being slightly flexed. The olecranon process and head of the radius can be felt in front of the lower end of the humerus—the latter can be distinguished

by the movement imparted to it on making rotation of the forearm. Posteriorily, the end of the humerus with the smooth articular surfaces, condyles, and olecranon fossa may be outlined. Extension of the forearm can be effected without much effort. When the dislocation is incomplete, lengthening, instead of shortening, of the forearm is present, with flexion.

In the incomplete *outward lateral* dislocation, which is the usual form, the head of the radius does not entirely separate itself from the articular surface of the humerus. The ulna also remains in partial contact with the trochlear surface. In the complete variety the radius is carried beyond the external condyle, while the ulna surmounts it. As a result of this lateral displacement of the bones of the forearm, the elbow is increased remarkably in breadth and the muscles taking origin from the external and internal condyles are made very tense. The undue tension of the pronator radii teres produces forced pronation of the forearm. The action of the muscles upon the displaced bones, together with their abnormal positions, produce a twisted condition of the limb.

The *inward lateral* luxation is also characterized by great deformity of the limb, especially noted upon the ulnar side, and, as in the outward displacement, there is a great increase in the breadth of the articulation.

The forearm is maintained in a state of supination by the action of the supinator brevis and longus muscles, which are rendered tense, especially the former. In the complete variety of the dislocation the displaced olecranon process of the ulna may be felt on the inside of the joint, while on the outer aspect the external condyle forms a very prominent projection.

Diagnosis.—While the symptons accompanying the various forms of displacement of the elbow-joint are usually well marked and sufficiently distinctive, it requires, in many instances, the most careful examination and study to determine the exact character of the dislocation. Owing to the severe violence required to produce these injuries, contusions and lacerations of the soft structures occur, and as a result, great swelling rapidly supervenes. This condition interferes very much with a satisfactory examination of the parts and obscures the symptoms present. Fracture of the humerus above the condyles, of the olecranon process of the ulna or the neck of the radius may resemble posterior dislocation of the bones of the forearm, but can be distinguished from it by careful examination and comparison of the symptoms. Fracture of the humerus is characterized by the following symptoms: Position of the olecranon process normal, on a line with the condyles of the humerus; mobility of arm and forearm, flexion, extension, pronation, and supination preserved; crepitus obtained on bringing the fragments in contact and making rotation; no shortening of the forearm; end of upper fragment, forming prominence on anterior surface, rough and flattened; flexion of the arm diminishes prominence of posterior projection. In the *backward* dislocation of the radius and ulna the position of the olecranon process is above the line of the condyles—the movements of the limb restricted, forearm fixed, crepitus absent, anterior surface of forearm shortened, lower end of humerus smooth, presenting articular surfaces, flexion of arm increases prominence of posterior projection. In fracture of the olecranon process, the detached portion can be felt in its elevated position, and the depression caused by separation of the fragments can be easily recognized. In fracture of the neck of the radius,

there is an absence of deformity on the posterior surface of the articulation, and crepitus can be elicited on rotation of the bone.

Prognosis.—The injury inflicted upon the parts at the time of the production of the dislocation, as well as the great difficulties experienced in effecting reduction in one variety, the *backward* luxation, renders the prognosis doubtful. In the *backward* dislocation it is sometimes found impossible to effect reduction at the expiration of so short a period as the second or third week. Several instances are recorded, however, in which it has been accomplished after the lapse of six months. Severe inflammation, suppuration, and gangrene have followed long-continued attempts made at reduction. In one instance, rupture of the brachial artery occurred, necessitating amputation at the elbow-joint to save the patient's life. In another case, death followed the accident.

Treatment.—Reduction, in the different forms of dislocation of the elbow, may be effected by extension and counter-extension, with the arm in either the flexed or straight position.

In the *backward* dislocation, the method of Sir Astley Cooper may be employed, which consisted in seating the patient in a chair, while the surgeon, standing in front, placed the knee in the bend of the elbow, the foot resting upon the chair. The surgeon, grasping the forearm, makes extension, at the same time bending the elbow round the knee and pressing with it upon the inner surface of the joint so as to afford counter-extension and leverage. By the latter, the coronoid process is lifted out of the olecranon fossa, the efforts at extension being usually successful in restoring the bones to place. (Fig. 185.)

This method was modified by the late Prof. Gross, who

obtained more power by placing the heel in the bend of the elbow, made extension by grasping the forearm, and assisted reduction by bending the forearm over the chest. To afford still greater power, bands may be secured to the forearm and then placed over the shoulders of the surgeon. In effecting reduction by this plan the patient is placed in the recumbent position.

Fig. 185.

Reduction has also been accomplished by bending the arm round a bed-post while extension is made.

Pressure made firmly upon the displaced olecranon process by the thumbs of the surgeon while extension and counter-extension is effected by assistants, who grasp the arm and forearm, will sometimes aid in obtaining replacement.

In cases which resist reduction with the arm in the flexed position, the coronoid process may be unlocked from its position in the olecranon fossa by forcibly extending the limb beyond the straight line and then accomplishing reduction by extension and counter-extension. This plan is very effectual in old dislocations.

If still greater power is required in making extension the compound pulleys, which may be fastened to the forearm by appropriate bands, may be employed. Counter-extension

is obtained by bands attached to the arm and secured to the bed-post or confided to the care of strong assistants. Great care should be exercised in making traction lest injury be inflicted upon the structures of the joint. The patient should be in the recumbent posture and under the influence of an anæsthetic.

When all other means fail in effecting reduction, subcutaneous division of the tendon of the triceps muscle or subcutaneous section of the olecranon process may be performed with great advantage.

Subcutaneous division of resisting structures in close proximity to the important vessels and nerves in relation with the joint is attended with very great danger and may result in very serious consequences.

Reduction in the *forward* and *lateral* dislocations may be accomplished by the same methods as those employed in the backward displacement, that is, extension and counter-extension in the flexed or straight position, combined if necessary with pressure.

The return of the bones to their normal positions is accompanied by a characteristic sound, and the functions of the joint are restored. The re-establishment of complete flexion and extension, and of the normal relations of the olecranon process to the condyles of the humerus, will always indicate successful reduction of the dislocation.

The treatment after reduction consists in the local application of remedies to control inflammatory action, and the adaptation of an angular splint, with compresses over the joint to prevent the recurrence of displacement.

At the end of a week or ten days, the inflammation having sufficiently subsided, passive movements may be carefully instituted.

Compound dislocations of the elbow are rare, and are the result of extraordinary violence. They may be treated either by replacement of the displaced bones and closure of the wound, partial or complete resection of the bones, or amputation. The age, habits, and the state of the general health of the patient, with the nature and extent of the injury, will guide the surgeon in making a decision as to the best plan of treatment to be adopted. If the patient is young and in good health and the injury slight, an effort may be made to conduct treatment by replacing the bones, closing the wound, and applying antiseptic dressings. If the injury is more extensive, partial resection of the bones may be performed and the joint treated by the strictest antiseptic methods. In those cases in which injury has been inflicted upon the bloodvessels and nerves of the joint, with extensive lacerations of the muscular structures, amputation should be performed.

Several cases of a peculiar form of dislocation have been reported, in which a simultaneous luxation of the ulna and radius occurs in *opposite* directions, the former being thrown behind and the latter in front of the humerus. It is the result of severe violence applied, when the forearm is flexed and twisted forcibly upon its axis. The nature of the injury is recognized by the increase in the antero-posterior diameter of the articulation, with a decrease in the transverse measurement; also by the presence of a prominence both upon the anterior and posterior surfaces of the joint, caused by the head of the radius and olecranon process of the ulna. The deformity is very striking, the forearm and hand being both twisted inwardly and slightly bent.

Replacement of the dislocated bones may be accomplished by extension and counter-extension with flexion, made in

the usual way. The ulna is first returned to place and then the radius by extension, combined with pressure upon its head.

RADIUS AND ULNA—INFERIOR RADIO-ULNAR ARTICULATION—LATERAL GINGLYMOID.—This articulation is formed by the lower end of the ulna, the rounded articular eminence of which is received into the sigmoid cavity on the inner side of the lower end of the radius. The bones are held together by the anterior and posterior radio-ulnar ligaments attaching the margins of the sigmoid cavity to the anterior and posterior surfaces of the ulna, with the triangular interarticular fibro-cartilage, binding the surfaces of the lower ends of both bones. The synovial membrane of the articulation extends between the articular surfaces of the ulna and radius and the lower end of the ulna and the interarticular fibro-cartilage. It has been called, from its extreme laxity, the *membrana sacciformis*. The movement of the articulation is limited to rotation of the radius around the head of the ulna, forward and backward, producing pronation and supination.

Dislocation of the articulation occurs in two directions, *forward* and *backward*. In the former, the anterior radio-ulnar ligament with the synovial membrane and interarticular fibro-cartilage are ruptured, the cartilage being torn from its attachment to the radius, and sometimes displaced with the head of the ulna, which rests on the anterior surface of the radius. In the latter, the posterior radio-ulnar ligaments with the synovial membrane and fibro-cartilage are lacerated, the latter being displaced with the ulna, which is lodged upon the posterior surface of the radius. Of the two varieties, the *backward* luxation occurs most frequently. As independent lesions, dislocations of this articulation are very rare;

they occur frequently in the partial form as complications of fracture of the lower end of the radius.

Causes.—The cause of dislocation of this joint is the application of violence in such manner as to produce very forcible supination or pronation of the hand, as in twists or wrenches.

In the *forward* luxation forcible supination of the hand is required to dislodge the bone from its articulating cavity, and place it upon the anterior surface of the radius.

In the *backward* displacement, force applied in producing extreme pronation of the hand is necessary in order to separate the articular surfaces and place the ulna upon the posterior surface of the radius.

Symptoms.—The symptoms vary in accordance with the nature of the dislocation. In both varieties loss of function and deformity are marked.

The chief symptoms of the *forward* dislocation are the position of the forearm and hand in fixed supination with flexion of the fingers and the presence, on the *anterior* surface of the forearm, just above the carpus, of a marked prominence due to the displaced head of the ulna.

In the *backward* luxation the symptoms are reversed. The forearm and hand are in a state of pronation, and immovably fixed, with slight flexion of the fingers. A prominence exists upon the *posterior* surface of the wrist at its outer border, formed by the head of the ulna, which is directed obliquely across the radius. A depression may be felt above the position of the cuneiform bone, and the styloid process and fifth metacarpal bone are not in line, as in the normal relations. The breadth of the lower end of the forearm is diminished, and the tense tendon of the extensor

carpi ulnaris can be distinctly felt in its course from the ulna to the fifth metacarpal bone.

Diagnosis.—If examination of the parts is made before the occurrence of much swelling, the nature of the dislocation can be readily determined. Difficulty may be experienced in ascertaining the exact character of the displacement, when the relation of the parts are altered by accompanying fracture.

Prognosis.—In uncomplicated dislocations the prognosis is favorable. Repair of the lacerated ligaments takes place slowly, and care should be exercised in order to avoid removing the retentive dressings too early.

Treatment.—Reduction may be effected in the *forward* displacement by flexing the forearm upon the arm, extending, and then forcibly pronating the hand, while pressure is made over the head of the ulna to assist in returning it to its articulating cavity.

In the *backward* dislocation, after flexion of the arm, extension of the hand should be made, combined with forcible supination.

The after-treatment should be conducted by the application of compresses over the articulation, in front and behind, secured in place by a firm roller, and a Bond's splint, or two well-padded straight splints, placed on the anterior and posterior surfaces of the forearm, and secured likewise by a roller.

Partial dislocation of this articulation is sometimes observed in persons of feeble constitutions, or in others after severe injury to the joint, or as a result of a fracture of the lower end of the radius in which the treatment has been defective. The hand remains in the position of abduction, owing to the relaxed and elongated condition of the liga-

ments. Very little can be done in obtaining complete relief. The repeated application of small blisters over the joint might be effective in overcoming the condition. Support, by means of a firm band or a strap made of soft material, should be given to the joint.

CARPUS—WRIST-JOINT—PARTIAL ENARTHRODIAL ARTICULATION.—This articulation is formed by the lower end of the radius, with the triangular interarticular fibro-cartilage above, and the scaphoid, semilunar and cuneiform bones below. A transversely elliptical concave surface is presented by the under surface of the radius and fibro-cartilage, into which the convex surfaces of the bones of the carpus is received. The ligaments which fasten the parts together are the anterior, posterior, internal, and external lateral. A large synovial membrane lines the articular surfaces and is reflected on the inner surfaces of the ligaments. The articulation has all of the movements of an enarthrodial or ball-and-socket joint, except rotation, namely, flexion, extension, abduction, adduction, and circumduction. The joint is very strong and well protected by the arrangement of the articulating surfaces of the bones and the fibro-cartilage, with the tendons passing in front and behind, and by the styloid processes which project on each side. Dislocation of the carpus is an exceedingly rare accident, so much so that its existence as an independent traumatic lesion was denied by Dupuytren. Later observations have shown that its occurrence is possible, and a number of cases have been made the subject of clinical study. I have had under my care two cases of luxation of the carpus, both of the posterior variety, occurring in boys, as the result of falls upon the hand, which were reported to the Philadelphia Academy of Surgery in March, 1881.

Fig. 186.

The dislocations which occur are the *backward* and *forward*: in the *former*, the carpus is placed upon the *posterior* surface of the radius and ulna, the posterior and lateral ligaments having been ruptured (Fig. 186). In the *latter*, the carpus takes a position upon the anterior surface of the forearm (Fig. 187), the anterior and portions of the lateral ligaments having been lacerated. Lateral dislocation can only occur when accompanied by fracture of one of the styloid processes, and then in the incomplete form.

Fig. 187.

Causes.—Dislocations of the carpus are, as a rule, the result of falls upon the hand when it is either in the flexed or extended position.

The *backward* luxation is caused by falls upon the back of the hand, producing very sudden and forcible flexion.

In the *forward* displacement the force is received upon the palm of the hand, causing sudden and forcible extension.

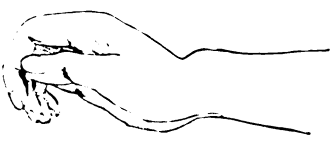
Symptoms.—The [illegible] of displacement are very characteristic—los[illegible] and deformity are marked.

In the *backwa*[illegible] projection exists upon the posterior surface o[illegible] part of the forearm, with another upon the ante[illegible]ce of the carpus, increasing very greatly the antero-posterior diameter of the joint. The hand and fingers are flexed and only slightly movable. The forearm is shortened on its posterior aspect (Fig. 188).

Fig. 188.

In the *forward* dislocation the antero-posterior diameter is increased, as in the backward luxation, the carpus, however, lying upon the anterior, instead of the posterior, surface of the forearm. The hand is markedly extended, with strong flexion of the fingers, and the forearm is shortened on its anterior aspect (Fig 189).

Fig. 189.



Diagnosis.—In most cases, before swelling to any extent has supervened, the outlines of the displaced carpus can be readily traced, and the

concave surface of the radius, with the styloid processes of both bones, distinguished.

The condition of flexion or extension of the hand and fingers will also assist in determining the position of the displaced carpus.

The differential diagnosis between dislocation of the carpus and fracture of the lower extremity of the radius is made by a careful examination of the parts and a study of the symptoms. Dislocations are characterized by greater deformity, immobility, absence of lateral displacements, and crepitus. Reduction, when effected, is permanent.

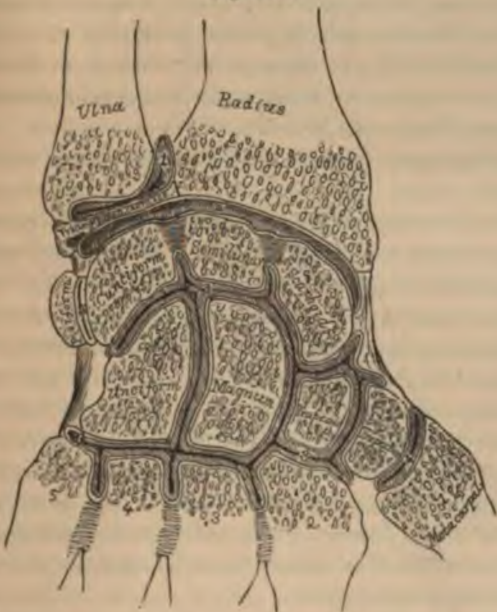
Prognosis.—The prognosis in dislocations of the carpus is favorable, reduction being usually easily accomplished, and the functions of the joint, in a short time, fully restored.

Treatment.—Reduction is effected by grasping the hand and making extension, the movements of extension and flexion of the hand, with abduction and adduction being executed at the same time and in accordance with the direction of the displacement, so as to facilitate replacement. Pressure exerted upon the displaced carpus will also assist in returning it to place. After reduction, the joint should be enveloped in compresses saturated with a lotion of laudanum and lead-water, and the forearm kept upon a well-padded anterior splint, held in position by a roller. At the expiration of eight to ten days passive motion should be carefully instituted.

The treatment of *compound* dislocation of the carpus should be conducted upon general principles. An effort should be made to save, if possible, the hand, the displaced bones being returned or excision being performed if necessary, the wound closed, and antiseptic dressings applied. Perfect drainage of the wound should be accomplished.

orm, and *pisiform*. A few cases of dislocation of an entire ow have been recorded—a notable one by Maisonneuve. As

Fig. 190.



a rule the dislocation occurs in the posterior direction, the bone being placed upon the dorsum, in the complete variety; two cases are reported, one by Prof. Chisolm, of Baltimore, in which anterior displacement occurred.

Causes.—Dislocation of the carpal bones takes place as the result of falls upon the hand when it is in a state of forced flexion, or in the forcible contraction of the hand and fingers in grasping the sheet or towel during the pains of labor.

maintain its relation with the metacarpal bones so as to fix its position. Sometimes the shape of the bone may be traced.

Prognosis.—The prognosis in simple dislocation is favorable, restoration and retention being usually easily accomplished. It is sometimes found difficult to retain the pisiform bone in place owing to the action of the flexor carpiulnaris muscle which has its insertion into it.

Treatment.—As the dislocations of the carpal bones are usually incomplete their reduction should be accomplished without much difficulty. It sometimes occurs that the swelling which accompanies the accident renders it difficult to return the displaced bone, and the efforts of the surgeon may be, for a time, unavailing. In effecting reduction of the os magnum, semilunar, or cuneiform bones the hand should be extended and pressure should be made on the bone in such a direction as to return it to its place. It may be necessary to employ continuous pressure by means of the tourniquet or other appliances. The manipulations should be made with care and in a gentle manner. If inflammation is present, local applications should be made to abate it; after reduction the forearm and hand should be supported by an anterior and posterior straight splint, a compress having been placed over the luxated bone. A roller should be applied to secure the dressings in position. At the end of two weeks the splints may be removed, and passive movement of the wrist-joint carefully made in order to prevent anchylosis. The splints should then be re-applied and worn for two weeks longer until repair of the ligaments is accomplished.

Replacement of the *pisiform* bone may be effected by flexing the hand upon the forearm and pushing the bone down into place. Efforts should be made to fix it in its restored position by strips of adhesive plaster and a bandage,

METACARPUS—CARPO-M
THE FINGERS—ARTHRODIA
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CARPO-METACARPAL ARTICU
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adduction, and circumduction.

Dislocations of the *metacarp*
extremely rare occurrences.
luxation of all of

Dislocations of the *metacarpal bone of the thumb* occur rarely in the complete and incomplete form.

Causes.—Dislocation of the *carpo-metacarpal articulations of the fingers* may be caused by direct violence, as in blows upon the back of the hand producing *forward* displacements; or by indirect force, as in blows given with the fist or falls upon the closed hand, giving rise to *backward* luxations.

Luxation of the *metacarpal bone of the thumb* is caused by force applied to the posterior surface producing extreme flexion or upon the distal end. The direction of displacement may be *backward* or *forward*, the latter occurring very rarely.

Symptoms.—The symptoms of dislocation of the *metacarpal bones of the fingers* are chiefly confined to the deformity caused by the displaced bone either upon the dorsal or palmar surface in accordance with a *backward* or *forward* dislocation. Pain and loss of function are not very marked. The limited mobility of the jöint is not materially affected.

The symptoms attending luxation of the *metacarpal bone of the thumb* are more prominent. In the *backward* luxation loss of function is present with marked deformity, caused above, by the proximal extremity of the metacarpal bone and below, by the trapezium. The position of the thumb varies, being either straight or somewhat flexed with slight adduction of the metacarpal bone. In the *forward* dislocation the symptoms are less distinct—the displacement being usually incomplete.

Diagnosis.—If examination is made before the occurrence of swelling when the displaced bone can be felt, the nature of the dislocation may be readily determined. A number of instances are recorded in which a failure to recog-

bones are connected by an anterior and two lateral ligaments, a synovial membrane lining the joint. The movements of these articulations are flexion, extension, abduction, adduction, and circumduction.

PHALANGES—PHALANGEAL ARTICULATIONS—GINGLYMOID JOINTS.—These articulations exist between the first and second, and second and third phalanges, the flattened lateral condyles of the heads being received into corresponding shallow cavities on the bases of the contiguous bones. The phalanges are united by an anterior and two lateral ligaments, the posterior ligament being supplied by the extensor tendons as in the metacarpo-phalangeal articulations. The movements of the joints are limited to flexion and extension; a slight degree of rotation may be obtained by manipulation. Dislocations of the thumb and fingers at the *metacarpo-phalangeal* and *phalangeal* articulations occur either in the *backward* or *forward* direction. The latter luxation takes place infrequently, very few instances having been recorded.

In *backward* dislocation of the *thumb* at the metacarpo-phalangeal articulation the anterior and lateral ligaments

Fig. 192.

are extensively ruptured, and the head of the first phalanx rests upon the posterior and inner surface of the metacarpal bone. (Fig. 192.)

fingers on account of the greater mobility of the joints and their more exposed positions. The position of the phalanges in forward dislocation is shown in Fig. 193. An instance

Fig. 193.

of the forward dislocation of all of the fingers at the metacarpo-phalangeal articulations has been reported by M. Serre, of Paris.

Causes.—The cause of luxation at the metacarpo-phalangeal and phalangeal joints is violence, directly and indirectly applied. In the *thumb*, falls upon the posterior surface of the last phalanx, producing extreme flexion, may cause *backward* luxation. The *forward* dislocation may be produced by making forced extension of the thumb. In the fingers, falls upon the last phalanges or the impact of great force, as when a base or cricket ball, impelled with great momentum, strikes the ends, slightly flexed or extended.

Symptoms.—The symptoms of dislocation of the thumb or fingers are usually very prominent. Deformity constitutes the chief symptom and is easily recognized. Impairment of function, in some forms of luxation, is quite marked. Pain, due to the displacement, is usually slight.

In the *backward* metacarpo-phalangeal dislocation of the *thumb* the deformity is characteristic, the thumb being shortened and turned inward, while flexion of the last phalanx is produced by contraction of the flexor longus pollicis. Two projections exist on the surfaces, caused by the head of the

metacarpal bone anteriorly, and the base of the first phalanx, posteriorly.

In the *forward* dislocation the position of the displaced bone is reversed, and the thumb is either straight, or the last phalanx is but slightly flexed.

Dislocations of the fingers at the metacarpo-phalangeal or phalangeal articulations are easily recognized by the symptoms they present.

Diagnosis.—The facility with which the parts can be examined renders the detection of the luxation quite easy.

Prognosis.—The great difficulties which are sometimes experienced in effecting reduction of the dislocation occurring at the metacarpo-phalangeal articulation of the thumb, and the injury inflicted upon the parts in the violent efforts made, render the prognosis doubtful. In the other luxations of the thumb and in all of those of the fingers, reduction is easily accomplished, and the restoration of the function soon takes place.

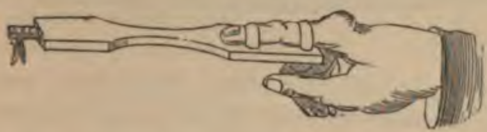
Treatment.—Reduction is effected by extension and counter-extension, the latter being obtained by grasping the

Fig. 194.

hand, while the former is made by grasping the finger between the thumb and fingers of the surgeon. In reducing

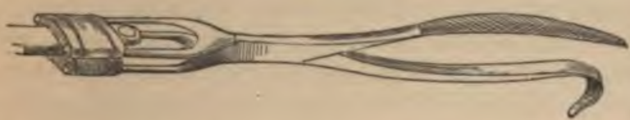
the displacement the finger should be placed in a position of forcible extension, and, as traction is made, the phalanx should be pressed forward into place. (Fig. 194.) If more force is required than can be secured by the fingers of the surgeon, appliances devised to retain firm hold of the finger

Fig. 195.



may be employed, as the lever-tractor of Dr. Levis (Fig. 195), traction forceps of Charriere (Fig. 196), the double

Fig. 196.

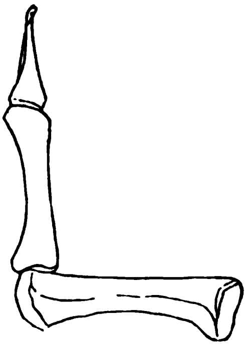


noose or clove hitch (Fig. 191), or the Indian puzzle (Fig. 197).

In the reduction of dislocation of the *thumb* at the metacarpo-phalangeal articulation, special manipulations are necessary on account of the relations assumed by the bones and the flexor brevis, and in some cases the tendon of the flexor longus pollicis muscle. Various methods have, from time to time, been suggested and practised with varying success. Extension and counter-extension made with great force have failed usually to accomplish reduction. Manipulations,

pressing the base forward into place. In order to accomplish this he places the hand of the patient on his knee, elevates the phalanx to a point slightly beyond the perpendicular, and grasps the base between his thumbs placed behind, and his index fingers in front. With this hold of the base of the bone great pressure can be exerted, forcing the base of the phalanx downward and forward until it glides over the head of the metacarpal bone. In cases in which all other methods fail subcutaneous section of the tendons of the flexor brevis muscle may be performed with great advantage.

Fig. 198.



Great care should be exercised in making forcible efforts at reduction. Very serious consequences have followed violent and injudicious attempts, such as erysipelas and gangrene. In one instance the thumb was torn off during forcible and long-continued efforts.

Reduction in the *forward* luxation may be accomplished by making extension followed by forcible flexion. If this plan is not successful, the phalanx may be placed in a position of forced extension and traction then employed.

Compound dislocations of the thumb and fingers should be treated in the same manner as those occurring in connection with other joints. Tetanus frequently follows the accident when much laceration of the soft parts has taken place.

lined by synovial membrane. In some instances, the elastic tissue is entirely absent, permitting the synovial cavity to extend the entire length of the cartilages, and giving, as a result, greater latitude of movement to the articulation.

Dislocations, usually incomplete in form, may occur at any of the articulations above mentioned. They are generally associated with fracture or injury to the bloodvessels and viscera of the pelvis. In *sacro-iliac* dislocations the displacement of the ilium is *upward* and *backward*. In the *sacro-coccygeal* luxation it may be either in the *forward* or *backward* direction, while in separation of the *pubes* the bone of either side may be displaced in the *forward* or *backward* direction. Where the separation of the articulating surfaces is extensive the ligaments are ruptured; usually they escape laceration, but are subjected to great tension.

Causes.—Great violence applied directly is necessary to cause separation at the *sacro-iliac* and *pubic* articulations, as crushes by heavy masses of earth, rock, or coal, between the drawheads of railway cars, or between a wall and a wagon in motion. It may be also produced by violent kicks or blows directly over the parts. A case is reported by Dr. Thomas Harris, of this city, in which partial dislocation of both sacro-iliac and pubic articulations occurred in a woman as the result of a blow, by her husband, with the fist, delivered upon the sacrum. During pregnancy, in some instances, the ligamentous structures of the pubic joint become relaxed and softened, so as to permit dislocation, in the incomplete form, upon the application of slight force. Instances are recorded in which separation, with but slight displacement, has occurred during parturition.

Sacro-coccygeal dislocations may occur from the application of force applied externally, as in kicks or falls upon

the buttocks, or internally, by the pressure exerted by the child's head in its passage through the pelvis, during parturition.

Symptoms.—The symptoms of unilateral dislocation of the *sacro-iliac* junction, in which the displacement backward is extensive, are usually well marked. Pain, loss of function, and deformity, are very prominent. The pain is very severe, and prevents recumbency upon the back. The limb of the affected side is shortened, and its function is greatly impaired by reason of injury to the sacral nerves. Deformity is caused by the projection upward and backward of the posterior border and crest of the ilium, and the tuberosity of the ischium occupies a higher position than that of the sound side. Severe contusion of the soft parts usually accompanies the injury, and the patient is unable to pass his urine.

In *pubic* dislocations, due to traumatism, the symptoms relate principally to the condition of the pelvic organs which are usually seriously involved. In extensive separation of the articulating surfaces the deformity is well marked. Pain is sometimes very pronounced and increased on movement.

The *symptoms* of *sacro-coccygeal* luxations are similar, in some respects, to those of the sacro-iliac junction. Pain is very marked and constant, and is increased on defecation. Tenesmus is present, with retention of urine. The displacement, whether in the *backward* or *forward* direction, may be recognized on inspection.

If the former exists, a prominence will be felt over the region of the articulation; and if the latter, a depression can be outlined with the finger. In some instances a late-

ral displacement may occur, as in the case reported by Dr. Roeser.

Diagnosis.—A careful examination of the parts is usually necessary to detect the displacements occurring in different forms of pelvic dislocations. Occasionally the swelling, which rapidly supervenes, obscures the symptoms and increases the difficulty in making a diagnosis. In dislocations of the coccyx, the nature of the injury can be detected by introducing the finger into the rectum and making, in this way, an exploration of the parts.

Prognosis.—The violent injury inflicted upon the contents of the pelvic cavity and surrounding structures in dislocation of the pelvic articulations renders the prognosis unfavorable. More or less disability, with pain, remains after the occurrence of the injury. The sacro-coccygeal articulation becomes the seat, sometimes, of a very painful and persistent neuralgic affection. In some cases reduction of the dislocations in the various joints cannot be effected, and the deformity is not removed.

Treatment.—In *sacro-iliac* and *pubic* dislocations, reduction is accomplished by pressure and counter-pressure made on opposite sides of the pelvis. In luxations of the *coccyx*, pressure can be exerted by introducing the finger of one hand into the rectum, and bringing it in contact with the bone, while counter-pressure is made with the fingers of the other hand placed on the outside. After reduction, the pelvis should be surrounded by a broad bandage, firmly applied, and the patient should rest in bed for ten days, two weeks, or longer, if necessary. Careful attention should be given to the functions of the rectum and bladder. Defecation is usually painful and is accomplished with effort, and should be assisted by enemata, in order to prevent recurrence of

notch, and converts it into a foramen. A large synovial membrane covers the interior of the joint. A number of muscles are in relation with the articulation, some of which take part in the displacements occurring in connection with dislocations of the joint. The movements of the articulation are very extensive and occur in all directions, as extension, flexion, abduction, adduction, circumduction, and rotation.

Owing to the very secure manner in which the head of the femur is lodged in the acetabular cavity by reason of its depth, the large contact of articulating surfaces, the arrangement of the strong ligaments of the articulation, and the protection afforded by the powerful muscles in relation with the joint, complete dislocation is accomplished only, as a rule, after the application of extreme and sudden violence. In the complete separation of the articular surfaces extensive laceration of the ligamentous and muscular structures occurs. Of the ligaments, the capsular and ligamentum teres are ruptured, the former usually in that portion not protected by the ilio-femoral or Y ligament. In dislocations, the result of extraordinary violence, producing the rarer forms of displacement, the ilio-femoral ligament is also torn. The muscles in immediate relations with joints, and those attached to the trochanter major especially, are liable to be ruptured. The larger muscles, and those whose insertions are more remote from the head, on this account affording them more play, escape laceration. With the exception of the great sciatic nerve, the large vascular and nerve trunks are not involved in hip-joint luxations. In some instances, severe contusions of the soft parts accompany the accident. A number of instances of *spontaneous* dislocation of the hip-joint have been recorded, in which the displacement

is always incomplete and unattended by rupture of the cap-sular ligament.

Dislocations of the hip-joint occur next in frequency t those of the shoulder-joint and second in the list of luxation of the different joints of the body. Of 491 cases collecte by Malgaigne, 321 occurred in the shoulder and 34 in th hip. According to the statistics of the Pennsylvania Hos-pital, as reported by Prof. Agnew, 89 cases of hip-joint lux-ations occurred in 912 cases of dislocations admitted into th Hospital.

The same causes which determine the occurrence other injuries in males and females exist in hip-joint dis-locations, males suffering always in very much larger pro-portion than females.

Age has also an important influence. Of the 89 cas taken from the records of the Pennsylvania Hospital 7 were males and 11 females; 39 occurred between the ag of fifteen and twenty-five years, 26 between twenty-fiv and thirty, 12 between thirty-five and forty-five, 6 betwe forty-five and fifty-five, 5 between fifty-five and sixty-fiv and 1 between sixty-five and seventy-five. According to t table of Prof. Agnew, given above, luxation of the joint most frequent between fifteen and twenty-five years of ag Prof. Gross states that dislocation often occurs between t ages of twenty and twenty-five, but is most frequent from t thirtieth to the forty-fifth year. Two cases of hip-joint disl cation are reported as occurring in children at the age of s months, and five cases, from the records of the Pennsylvan Hospital, between seventy-five and eighty-five years of ag The absence of muscular power in the very young and i loss, with a condition of fragility of the bones, conducing

fractures, in the old, contribute to the infrequent occurrence of dislocations at these periods of life.

The results of the investigations of Mr. Henry Morris of London, published in 1877 in the *Medico-Chirurgical Transactions*, have shown that abduction of the limb is the position most favorable to the occurrence of dislocations of the hip-joint, the head of the femur being largely displaced from the acetabulum while the limb is abducted. The conclusions, arrived at by Mr. Morris, have been confirmed by him by experiments made upon the cadaver, as well as by clinical observations. They are not, however, accepted by others who have made special study of the subject.

Varieties of Displacement.—Dislocation of the head of the femur may take place in four different directions: *backward* and *upward*, upon the dorsum of the ilium, *iliac* dislocation; *backward* and *upward*, into the great sacro-sciatic or ischiatic foramen, *sciatic* or *ischiatic; forward* and *downward*, into the obturator or thyroid foramen, *obturator* or *thyroid; forward* and *upward* on the pubes, *pubic*. Variations, to slight degree, in the positions assumed by the head of the femur in the four principal forms described may occur; practically they exert but little or no influence.

Of the chief forms above mentioned, dislocation upon the dorsum ilii occurs most frequently, next, that into the ischiatic foramen, then, the thyroid variety, and finally, the pubic, which occurs quite rarely. The relative frequency is shown in the cases collected by Prof. Hamilton, who gives, out of 104 instances, 55 iliac, 28 ischiatic, 13 thyroid, and 8 pubic. The same order of occurrence appears in the table prepared by Mr. Bryant from the records in Guy's Hospital.

A number of instances of *simultaneous* dislocations of the hip-joint have been reported; in some, the luxation was in

the same direction and position; in others, they have varied, one being an iliac dislocation and the other a thyroid.

The frequent occurrence of the posterior displacement is to be explained in the manner, in which, and the direction, from which, the vulnerating force is applied, as well as the attitude of the limb at the time of the impact of the force. In most instances, the violence is applied from the front, upon the foot or knee, the limb being at the time advanced causing flexion of the thigh upon the pelvis and in a state of abduction and internal rotation. Under such conditions, the force would be conveyed through the bone upon its head in such direction as to project it backward and upward upon the dorsum of the ilium. Force applied in the same way, with the femur still more flexed, would be liable to produce dislocation backward and downward into the sciatic foramen.

Causes.—As stated above, extreme and sudden violence is necessary to dislodge the head of the femur from the acetabulum. This may be applied directly or indirectly, in the latter manner more frequently than in the former; as in falls upon the knee or foot, by crushes by heavy weights upon the back, the thighs being flexed and widely separated, or twists of the pelvis, while the lower extremity is fixed.

In the *iliac* dislocations, the causes are usually falls upon the knee or foot, the limb being advanced, the thigh flexed, abducted, and rotated internally.

In the *ischiatic* luxation the causes are the same as those concerned in the production of the iliac variety. When ischiatic displacement occurs, however, the thighs are at a greater degree of flexion, exceeding that of a right angle, the limb abducted, and rotated strongly internally.

Thyroid dislocations are caused by falls upon the knee or foot, the limb being markedly abducted and drawn backward, and rotated outward. They may also occur as the result of the impact of great force upon the hip, while the body is bent forward, the limb being abducted and retracted.

Pubic luxations occur as the result of force applied in the same manner as in thyroid dislocations, the limb being abducted and retracted. Heavy weights upon the shoulders which fix the trunk, assist in the production of this form of displacement. It may also occur when the thighs are firmly held and the trunk is bent forcibly backward. A notable case is reported by Mr. Ure, of London, in which this form of dislocation occurred in a swimmer, while vigorously "striking out" in the act of swimming.

The position of the limb, in the various dislocations above mentioned, has been described as that of *abduction*, as given by Mr. Morris, with flexion and rotation. Others describe the position as that of *adduction*. Rotation, either internal or external, is an important factor in determining the dislodgment of the head of the femur and the direction taken by it subsequently. Abduction, with flexion and *internal* rotation, will determine a backward displacement of the head of the femur, the luxating force continuing to act. Abduction, with extension and *external* rotation, will accomplish a forward displacement, the force continuing to act. It would seem natural that, in a vast majority of instances, the head of the bone should escape at the anterior inferior portion of the capsule, where the rim of the acetabulum is deficient, its place being supplied by the transverse ligament. After its exit from the capsule, or while in progress of dislodgment, the bone is carried anteriorily or

posteriorily, in accordance with the position of the limb while the force is exerted upon it.

Symptoms.—Pain, loss of function, deformity, and immobility characterize all of the forms of hip-joint dislocation. The individual luxations are distinguished by variations in the symptoms peculiar to each form.

Iliac Dislocation.—In this variety the displaced bone is placed in the lower part of the iliac fossa, beneath or upon the gluteus minimus muscle (Fig. 199). In the dislocation, rupture of the capsular and round ligaments occurs with great tension and sometimes laceration of the obturator externus and internus, the gemelli, the pyriformis, and quadratus femoris muscles. The gluteal, adducters, and pectineus, with the muscles inserted into the lesser trochanter, are relaxed. Pain is present and increased at efforts of movement; impairment of function is very great, and the limb is fixed in its position. The deformity is very prominent, affecting the appearance of the entire limb. The position of the head of the femur upon the external surface of the ilium renders the hip very prominent. In persons, not too corpulent, it may be felt moving during rotation of the thigh. The trochanter major is in much closer rela-

Fig. 199.

tion with the anterior superior spinous process than normal. The thigh is flexed upon the pelvis and the leg upon the thigh. The limb is markedly adducted, the knee, when the patient is in the erect position, is advanced beyond that of the opposite side and elevated above it. The foot is strongly inverted, the heel raised from the floor, the base of the great toe resting upon the inner side of the tarsus of the opposite foot with the point of the toe directed obliquely across the foot. (Fig. 200.) The movements of flexion and extension can be made to very slight extent, adduction to much greater extent, while abduction cannot be accomplished without great effort and accession of pain. Shortening of the limb exists from one to two and a half inches.

Fig. 200.

Fig. 201.

Ischiatic or Sciatic Dislocation.—In this form of displacement, the head of the bone is thrown *backward* and *slightly upward* into the sciatic foramen, occupying its lower portion, and resting upon the lesser sacro-sciatic ligament, in its middle upon the pyriformis muscle, or in its upper portion between the upper border of this muscle and the

margin of the ilium. (Fig. 201.) The capsular and teres ligaments are ruptured, while laceration, to a greater or less extent, of the gluteal, obturators, gemelli, and quadratus femoris muscles may occur, the psoas and iliacus being rendered very tense. The symptoms, in general, of this variety resemble very closely those of the iliac dislocation, being somewhat less in degree. The position of the displaced head of the bone is nearer to the normal articulating cavity, and therefore the changes in the relations are not so great. The lodgment of the head in the sciatic foramen renders it less prominent and difficult to outline; the great trochanter is not so near to the anterior superior spinous process as in the iliac luxation; the flexion of the thigh and leg is not so marked; the adduction of the limb and the advancement of the knee and its elevation above that of the sound side are less. The heel of the foot of the injured side is slightly raised, and the great toe rests in contact with the inner side of the opposite foot at the metacarpo-phalangeal articulation of the corresponding toe. (Fig. 202.) The shortening of the limb is much less, not exceeding usually an inch. The immobility of the limb is very marked, greater than in iliac displacement, and its

Fig. 202.

movements are very much restricted. If the patient is placed in the recumbent position, and extension of the thigh made, the back is arched; this condition disappears on flexion. Sometimes pressure is exerted by the head of the bone upon the great sciatic nerve, producing pain and numbness.

Thyroid Dislocation.—In the thyroid dislocation the head of the femur is thrown forward and downward into the obturator or thyroid foramen, where it rests upon the obturator externus muscle. (Fig. 203.) The capsular ligament is

Fig. 203.

ruptured, the teres sometimes escaping, as shown in a dissection made by Prof. Agnew. The gluteal muscles, with the pyriformis are rendered tense, giving to the hip a flattened appearance. The great trochanter is placed downward and in front of the acetabulum resting upon its lower margin, in which position it is widely removed from the an-

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206.) Adduction and internal rotation of the limb cannot be executed on account of the fixed position of the head of the bone upon the ramus of the pubes.

Fig. 205.

Fig. 206.

Diagnosis.—Although the symptoms of the various forms of hip-joint dislocations are prominent and distinctive, yet the importance of avoiding error in making a diagnosis is so great that, in every case of suspected luxation, the patient should be subjected to the most critical examination. For this purpose he should be examined first in the erect position, with all clothing removed, and then he should be placed in bed, and an anæsthetic should be administered until complete anæsthesia is produced. The examination should be con-

ducted by inspection, mensuration, and manipulation of the parts. Inspection will enable the surgeon to ascertain the character and extent of the deformity; by mensuration he can establish the existence of the disturbed relations of prominent fixed points, and by manipulation he may be able to distinguish the position of the displaced head of the bone or the presence of the diagnostic signs of other lesions. The examination must have for its object not only the distinction of the dislocation from other lesions which may present in some respects analogous symptoms, but also the differentiation of the various forms of hip-joint luxations.

Measurements of the parts or limbs are best made by a tape, graduated measure, or rule. In ascertaining the existence of shortening or lengthening, the measurements should be made from the apex of the ensiform cartilage to the sole of each foot, placed at right angles to the leg, or from the anterior superior spinous process of the ilium to the internal condyle of each femur. The measurements may also be taken, in those forms in which it is possible, chiefly the sciatic, when the limbs are flexed at right angles to the trunk, the patient being in the recumbent posture, as suggested by Dr. Allis, of this city. In this position of the thighs the shortening is made very apparent. The extent of the change in the position of the great trochanter to the fixed points of the pelvis may be determined by measurements with the rule or tape.

The method of examination suggested by Nélaton may be employed with great advantage in determining its relations in the posterior displacements. The method consists in flexing the thigh at a right angle to the pelvis and drawing a line from the anterior superior spinous process of the ilium to the most prominent part of the tuberosity of the ischium; this will cross the cavity of the acetabulum, divid-

ing it into two equal portions and touch the top of the trochanter major. Displacement may be inferred to exist if the trochanter projects to a notable degree above this line, fracture of the neck of the femur being absent.

The different lesions which present symptoms resembling in some particulars those of recent dislocations of the hip-joints are fractures of the *neck of the femur*, of the *acetabulum*, or of the *great trochanter*, contusions of the *great trochanter* and *joint*, and in old luxations, *coxalgia* in certain of its stages. In these cases the differential diagnosis is made by a careful study and comparison of the symptoms present. The existence of fracture may be determined by mobility and crepitus, of contusions, by the perfect movements of the articulation under anæsthesia and of coxalgia, by a careful inquiry into the history of the case and examination of the joint, if necessary, under anæsthesia, to ascertain the position of the head of the femur and the movements of the articulation.

The position of the displaced head of the bone can, in most varieties, be felt by making pressure with the fingers over the region occupied by it. In emaciated subjects its movements may be seen. In one form—the sciatic—it may be felt through the walls of the vagina or rectum, the finger being introduced for this purpose.

The late Professor Gross suggested, in cases of doubt, the exploration of the cavity of the acetabulum with a long, sharp pointed needle. The passage of this into a deep cavity in the normal position of the acetabulum would indicate the absence of the head of the bone. While he deemed the procedure devoid of danger and of value as a means of diagnosis, he thought it rarely necessary in any case, the symptoms being usually too prominent to elude detection.

For the purpose of convenient examination and study, the symptoms of the various forms of hip-joint dislocations may be presented in tabular form, as follows :—

BACKWARD AND UPWARD. 1. Iliac ; dorsum ilii. 2. Sciatic ; sciatic foramen.	FORWARD AND DOWNWARD. Thyroid; thyroid foramen.	FORWARD AND UPWARD. Pubic ; on ramus of pubes.
Hip: Prominent.	Flattened.	Flattened.
Iliac ; great trochanter : Very conspicuous and closer to anterior superior spinous process of ilium than normal. Sciatic : Very prominent ; lower down and more remote from anterior superior spinous process than normal.	Not prominent ; remote from anterior superior spinous process.	Difficult to detect its position; depressed nearer middle line of body than normal.
Iliac : Limb firmly fixed in abnormal position ; inverted ; thigh flexed upon pelvis, leg upon thigh ; knee in advance and above that of opposite side ; foot raised from floor, inverted ; great toe resting on inner side of tarsus of other foot ; limb shortened 1½ to 2½ inches. Sciatic : Same as iliac, except less in degree ; limb shortened ½ to 1 inch ; shortening very perceptible on flexing both thighs at right angles to the trunk, the patient being recumbent ; arching of back on making extension of thigh ; great toe rests against the ball of opposite foot ; toes in contact with floor; heel raised.	Limb fixed ; slightly flexed ; abducted ; advanced ; knee lower than opposite; toes on the floor ; heel raised ; foot slightly everted or straight ; widely separated from other foot ; limb lengthened from 1½ to 2 inches.	Limb fixed; abducted; everted ; thigh flexed on pelvis; leg on thigh ; knee nearly in line with opposite ; foot everted ; ball of toes on floor; heel slightly raised; limb shortened ½ to 1 inch.
Iliac : Head of femur easily felt on dorsum ilii, especially in lean subjects. Sciatic : Concealed in sciatic foramen ; difficult to detect ; may be felt through walls of vagina or rectum.	Head of bone forms a distinct tumor in thyroid foramen, felt more easily in thin subjects.	Head of bone seen and felt in groin just above Poupart's ligament.

Prognosis.—In uncomplicated recent dislocations of the hip-joint, the prognosis, as to reduction and restoration of the functions of the joint, is favorable. In luxations associated with fracture of the acetabulum or of the femur, difficulty may be experienced in effecting reduction, and more or less disability may remain. Fracture of the femur may occur during attempts at reduction, especially in old luxations, and serious injury may be inflicted upon the sciatic nerve in obtaining replacement in the ischiatic variety, resulting in permanent paralysis of the muscles supplied by it. In old unreduced dislocations the functions of the joint may be, to a certain extent, restored.

Treatment.—Reduction of the various forms of hip-joint dislocations may be effected by *manipulation* or *by extension* and *counter-extension.*

Reduction by Manipulation.—Although this plan had been employed by Prof. Nathan Smith and others occasionally, it was not generally adopted or practised as a systematic method until 1852, when Dr. W. W. Reid, of Rochester, N. Y., published a paper upon reduction of the backward and upward dislocations of the femur by a definite method of manipulation. He regarded the difficulties encountered in the reduction of hip-joint luxations as due to muscular contraction, and the principle upon which his method was founded, consisted in securing by manipulation the relaxation of these structures. Later experiments in 1853, by Prof. Moses Gunn, showed that the muscles did not participate to any marked extent in offering resistance to the return of the displaced bone, but that the impediment rested chiefly, if not altogether, in the untorn portions of the capsular ligament which held the head firmly in its displaced position, and

that reduction by forcible extension was only accomplished by causing laceration of this portion.

Reduction by manipulation, he claimed, could be easily effected "by placing the limb in such position as will effectually approximate the two points of attachment of that portion of the ligament which remains untorn."

In 1869 Prof. Henry I. Bigelow published an elaborate monograph upon the *Mechanism of Dislocation and Fracture of the Hip*, in which he recognized the "anterior portion of the capsular ligament as the exponent of the total agency of the capsule in giving position to the dislocated limb, and, what is more important, as so identified with the phenomena of luxation, that reduction must be accomplished almost wholly with reference to it." The anterior portion of the capsular ligament is composed chiefly of the ilio-femoral ligament, which takes its origin from the anterior inferior spinous process of the ilium, and crossing downward to the front of the femur is inserted by two fasciculi into nearly the whole of the anterior intertrochanteric line, being about half an inch wide at the point of origin and two inches and a half wide at its insertion. It resembles an inverted Y and was designated

Fig. 207.

by Prof. Bigelow as the Y-ligament. (Fig. 207.) It is very strong, being nearly a quarter of an inch in thickness, and in experiments made, required for its rupture the attachment of weights ranging from two hundred and fifty to seven hundred and fifty pounds. It forms an "unyielding suspensory band by which the femur when in a state of extension as in walking is forcibly retained in its socket." The function of the internal or anterior branch is that of limiting the extension of the femur, while the external or posterior limits the eversion. This ligament, as stated above, plays an important part in the mechanism of hip-joint dislocations, and in the manipulations, to effect reduction in the various displacements, the limb should be placed in such positions as to relax this band and utilize it in replacing the head of the bone. This is accomplished chiefly by flexion, which is the important element in all manipulative efforts.

The different steps in reduction by manipulation are *flexion*, *adduction* or *abduction*, *rotation*, and *circumduction*.

In *iliac* dislocations reduction by manipulation is effected in the following manner: The patient should be placed on a low bed upon a firm mattress, or preferably upon the floor, and anæsthesia should be produced. The surgeon standing or kneeling by his side should grasp the ankle with one hand and the knee with other, and flex the thigh upon the pelvis and the leg upon the thigh. The limb should now be adducted, slightly rotated outward, and then carried outward by external circumduction across the abdomen and placed in its natural position by the side of its fellow.

The method *by traction*, as designated by Prof. Bigelow, is executed as follows: "Lay the patient, when etherized, on his back upon the floor, flex the leg upon the thigh, the thigh upon the abdomen, *adduct* and *rotate* it a little *inward* to

disengage the head of the bone from behind the socket. The Y-ligament is then relaxed. If the bone can now be abducted beyond the perpendicular, the capsule and other tissues are so torn or relaxed that reduction may be accomplished without difficulty. The thigh need only be forcibly lifted or jerked toward the ceiling, with a little simultaneous circumduction and rotation outward, to direct the head of the bone toward the socket." Traction may also be performed by placing the foot, divested of the shoe, on the anterior superior spinous process of the ilium, or on the pubes while the flexed knee is drawn up.

Reduction may also be effected by *flexion*, *abduction*, and *rotation outward*, performed in the order named. Flex the thigh, abduct or circumduct it outward and rotate it outward. A little consideration will explain the effect of these movements upon the head of the displaced bone. By flexion the muscular and ligamentous structures are relaxed. Abduction of the limb keeps the head of the bone in contact with the dorsal surface of the ilium. Circumduction and rotation outward causes the head of the bone to glide over the border of the acetabulum into the socket.

If, in any case, the opening in the capsule is too small to permit return of the head of the bone it may be enlarged, as suggested by Prof. Bigelow, by circumduction of the flexed thigh across the abdomen "in a direction opposite to that in which it is desired to lead the head of the bone, which should be made in this way to pass across below the socket, and never above it, across the Y-ligament." The subcutaneous rupture of the Y-ligament is an injury of not much importance when the advantages gained are considered. The strength of the Y-ligament permits this rupture to take place, "it being strong enough to rupture the whole of

the rest of the capsule and the obturator muscle, without itself yielding." This laceration of the capsule by circumduction of the thigh is performed instead of the operation suggested by Dr. Reid, of enlarging the capsule by incision in case the opening is too small to permit return of the head of the bone.

Ischiatic or *sciatic* dislocations may be reduced by the same manipulations as iliac, namely, flexion, abduction, and rotation outward. The difficulty sometimes encountered in effecting reduction in this variety by extension, is due to the position of the tendon of the obturator internus muscle and capsule between the head of the femur and the acetabulum. Flexion and circumduction inward relaxes the tension of the muscle and permits the head to be lifted easily into place. Care should be observed in making abduction in these varieties not to employ too much force lest the capsular ligament be unduly torn and permit the bone to pass in *front* of the acetabulum.

Fig. 208.

In the *thyroid* dislocation the manipulations are in part the reverse of those executed in effecting reduction in the dorsal displacements. Flex the limb at a right angle to the pelvis, *abduct* it slightly and rotate the thigh strongly *inward*, *adduct* it and bring the limb in this position to the floor (Fig. 208). Reduction may also be accomplished by

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Reduction of the iliac,
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Sutton, of Indiana, in the
a lever to lift the head of
acetabulum.

Reduction by Extension.
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shoulder-joint luxations.

Extension may be made in
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be attached to the limb, as shown in Fig. 209. The traction should be made slowly, gently, and gradually until the head

Fig. 209.

of the bone reaches the margin of the acetabulum, when the surgeon, the traction being maintained, should grasp the leg and rotate the limb in a direction opposite to the displacement, in order to bring it into the articulating cavity. In posterior dislocations the limb should be adducted and the extension made in a line with the limb in this position (Fig. 209). In anterior displacements the limb should be abducted (Fig. 210), or the head forced out, as shown in Fig.

Fig. 210.

211. In employing vertical traction by the apparatus of Prof. Bigelow, rotation and elevation can be readily effected by the transverse and longitudinal rods attached to the splint (Fig. 212).

Evidence of the return of the head of the bone to its articulating cavity is sometimes afforded by a distinct "snap." Positive evidence is obtained in the complete restoration of

Fig. 211.

Fig. 212.

the movements of the limb, as flexion, extension, abduction, adduction, and rotation—in the re-establishment of the normal length and position of the limb as compared with its fellow, and ascertained by measurements.

The after treatment consists in rest in bed for ten days or two weeks, with the limbs fastened together at the knees, a compress being placed between them; at the end of a week passive movements may be carefully instituted to prevent stiffness or possible anchylosis of the articulation. The patient should walk with the aid of crutches for two or more weeks, and then with a cane to afford support to the injured limb. After four or five weeks the reparative process is generally complete.

Anomalous Dislocations.—As a result of extraordinary violence it sometimes happens that the head of the femur is forced into positions differing somewhat from those described as the usual or regular forms. These are designated anomalous dislocations, and when they occur, the bone may be placed above the margin of the acetabulum, between the anterior superior and inferior spinous processes of the ilium, below the border of the acetabulum, on the body and tuberosity of the ischium, in the perineum behind the scrotum, or under the arch of the pubes. The symptoms are usually so characteristic as to lead to a correct diagnosis as to the nature of the luxation. The treatment is conducted by manipulation, as in the ordinary forms, or by pulleys, if necessary. Reduction may be sometimes facilitated by changing the displacement of the bone into that of one of the regular forms, and employing the usual methods to accomplish replacement.

Incomplete Dislocations.—Much discussion has taken place with regard to the possibility of the occurrence of partial or incomplete luxations of the hip-joint. It is generally believed that the construction of the articulation will not permit, in the strictest sense, this form of displacement as the result of traumatism. Cases in which it has been

reported in medical journals as having occurred, have been recorded by Malgaigne, Hamilton, and Warren.

Subluxation of the joint sometimes occurs in persons of feeble habit in whom relaxation and elongation of the muscular and ligamentous tissues exist. Acrobats, who develop the muscular and ligamentous system to the fullest extent in their peculiar vocations, are frequently able to produce, at will, dislocation of this joint as well as of most of the freely movable articulations. Where it is desirable, mechanical support may be afforded by belts or bandages.

Complications of Hip-joint Luxations.—In discussing the prognosis of dislocations of the hip-joint allusion has been made to the occurrence of complications, as fracture of the femur or of the acetabulum, or laceration of the sciatic nerve. In fracture of the femur, taking place as a complication of dislocations, the broken bone should be dressed temporarily with short splints and bandages to give it requisite firmness while the limb is used as a lever in reducing the luxation, afterwards permanent dressings should be applied and the injury treated as in ordinary cases. In fracture of the acetabulum, extension by weights and pulley should be made after reduction, in order to retain the bone in place until repair has occurred. Laceration of the sciatic nerve should be treated by keeping the parts at rest and instituting, at the expiration of two or three weeks, passive movements with frictions, and, if required, applications of electricity.

Old Dislocations.—In view of the dangers which sometimes attend efforts at reduction in cases of old dislocations of the hip-joint, the propositions, stated on page 370 with regard to the conditions which should govern interference in old luxations of the shoulder-joint, may be, in general, accepted

in their application to chronic hip-joint luxations. The correction of the disability which accompanies unreduced hip-joint dislocations is, if anything, more important than in similar conditions in the shoulder-joint on account of the interference with locomotion, hence very careful consideration should be given to each case with the view, if possible, of affording relief. While the period of eight weeks, as fixed by Sir Astley Cooper, after which it is regarded imprudent to make efforts at reduction, is generally accepted by surgeons as correct, there are a number of instances on record in which reduction has been accomplished at periods ranging from six months to five years. The character of the dislocation will influence, to some extent, the propriety of interference and chances of success, as experience has shown that luxations of the *iliac* and *pubic* varieties yield much more readily than those of the *sciatic* and *thyroid*. In the latter, the head of the bone becomes immovably fixed at a much sooner period of time than in the former. Immobility of the head of the bone may be regarded as indicating the existence of firm adhesions which would seriously interfere with any attempts at reduction. It would also indicate the occurrence probably of severe inflammation subsequent to the receipt of the injury, which might cause changes in the condition of the acetabulum which would render the return of the head of the bone impracticable. The obliteration of the acetabulum, partial or complete, occurs more rapidly in the young than in the old. Sometimes no changes occur in the cavity, after dislocation, as in the dissection recorded by Fournier, where luxation had existed for thirteen years. Information might be gained as to the condition of the cavity by introduction and exploration with the exploring needle. The amount of disability present should guide

the surgeon in his decision with regard to interference; if a new joint has been formed which but slightly abridges the movements of the limb, it would be desirable not to interfere with it, lest injury should be inflicted upon the parts by the efforts made, without success, in accomplishing reduction and a full restoration of the function of the limb. A feeble state of health or advanced age would contraindicate the employment of efforts at reduction, on account of the shock produced by the violence and the inflammation liable to supervene.

Cases have been reported in which abscesses of very extensive character have formed after the movements made in endeavoring to effect reduction. In such cases the treatment should consist in free incisions and the introduction of tubes to secure free drainage.

When it is decided to make efforts at reduction, the patient should be subjected to preliminary treatment by gentle movements of the limb in order to sever the adhesions, and absorption of the plastic deposits should be promoted by the administration of small doses of mercury. Reduction should be attempted by manipulation, and if this failed, resort should be had to extension by the pulleys, made in the manner suggested by Prof. Bigelow, or in the longitudinal direction. The angular extension is adapted best for dorsal luxations. In the efforts made by manipulation the neck of the femur is sometimes broken, an accident which is generally followed by good results, as far as relates to the correction of the deformity and the restoration of the function of the limb by the establishment of a false joint. In cases in which reduction cannot be effected and where the disability is great, an artificial joint should be formed by subcutaneous

section of the neck of the bone, as performed in the surgical neck of the humerus in old shoulder-joint luxations.

Congenital Dislocations.—A number of cases of congenital dislocation of the hip-joint have been carefully examined and recorded. The structural deficiencies involve the acetabulum, head and neck of the femur and ligaments of the articulation, showing partial or complete obliteration of the first, atrophy and distortion of the second, and elongation and relaxation of the third, with sometimes an entire absence of the teres ligament. It may occur as a bilateral or unilateral condition, the number of cases being about equally divided; females are affected more frequently than males. The varieties of the dislocation are usually the *iliac*, *thyroid*, and *pubic*. The affection is not usually detected until efforts at walking are made by the child, when the symptoms are found to be quite characteristic and easily recognized. The elongation of the ligaments and the absence of the firm support of the acetabulum and head and neck of the femur permit the pelvis to descend between the thighs giving rise to a peculiar gait. In the recumbent position the limbs can be lengthened or shortened without causing pain to the child. In the great majority of cases the treatment can only be palliative, support being afforded by strong bands or belts fastened around the pelvis so as to hold the thigh bones against it. Subcutaneous section of the muscles inserted into the great trochanter has been performed by Mr. Brodhurst, of London, with benefit to the patient.

PATELLA.—The anatomical relations of the patella have been fully discussed on page 259 in connection with fractures of the bone.

Dislocations of the patella may occur in the *outward* (Fig. 213), *inward* (Fig. 214), *upward*, *downward*, and

vertical direction. In *complete* displacements, the tendinou
structures of the quadriceps extensor femoris muscle ar

Fig. 213. Fig. 214.

lacerated, to a greater or less extent, as well as the syno
membrane of the knee-joint.

Causes.—Dislocations of the patella are caused by di
violence and muscular action, the latter being the most
quent cause. The influence of muscular action is exe
in dancing or leaping, or in sudden twists of the leg,
thigh being extended and fixed. The bone may be
placed by blows, forcing it outward or inward. In per
in whom a relaxation of the ligamentous tissues exists, l
tion may be easily produced by muscular action comb
with a slight rotation of the leg.

Symptoms.—In the *incomplete* displacement the i
articulating surface of the patella rests upon the articul

surface of the external condyle, the inner edge lying in the intercondyloid groove. The displaced bone in its abnormal situation increases the breadth of the knee, forming a prominence over the external condyle, which may be felt and the edges of the bone distinguished. A marked depression exists over the front of the knee. The limb is fixed in the extended position, efforts at flexion causing great pain. In the *complete outward* dislocation the bone rests in an oblique position upon the anterior and outer surface of the external condyle, the anterior ligament and synovial membrane being ruptured.

In the *inward* luxation, a rare form of displacement, the conditions are reversed. In the complete variety the patella is forced beyond the internal condyle, the edges directed antero-posteriorly, and the articulating surfaces resting against the outer surface of the condyle. The internal surface of the joint is rendered prominent, and the knee is increased in width.

The *vertical* dislocation is also of very rare occurrence. In this form the bone is turned upon its edge, firmly fixed in the groove between the condyles behind and the tense integument in front. The symptoms are very marked. Pain is very intense and increased on slight efforts to move the limb, which is fixed in a state of extension. The quadriceps extensor femoris muscle is tense. The bone can be readily felt in its position. A few instances have been reported in which the patella has been completely turned over, the articulating surface being placed anteriorly.

The *upward* dislocation may occur as the result of pathological changes in the knee-joint or of rupture of the ligamentum patellæ. In the former the displacement is gradual, in the latter sudden. The elevation of the bone makes a

prominence above the condyles and leaves a marked depression over the front of the knee-joint.

In the *downward* luxation a rupture of the extensor muscle occurs at the point of its attachment to the upper border of the patella, leaving a depression between two prominences, that above formed by the torn tendon of the muscle and that below by the patella. The functions of the limb are impaired and the knee-joint is swollen and painful.

Diagnosis.—Examination of the parts before much swelling has occurred will enable the surgeon to detect the nature of the dislocation in the various forms described. The *upward* luxation is to be distinguished from fracture by the intact condition of the patella and the presence of the depression below the prominence and not between two portions of it.

Prognosis.—The prognosis is favorable as to reduction and restoration of the functions of the part. In some cases difficulty is experienced in effecting reduction in the vertical dislocation. In one instance severe inflammation of the knee-joint followed section of the ligamentum patellæ and quadriceps extensor muscle made in order to promote reduction, causing ultimately the death of the patient by profuse suppuration and hectic.

Treatment.—In the *outward and inward* dislocations the reduction may be easily effected by placing the patient in bed in the recumbent position, while the surgeon sitting on the edge places the heel of the injured limb on his shoulder, in this way relaxing completely the quadriceps extensor femoris muscle. With the thumb and fingers the patella is pressed into place. In the *vertical* luxation great difficulty is often experienced in obtaining reduction owing to the impaction of the bone in the intercondyloid groove, and the locking of

the anterior edge in a slit of the fibrous expansion of the extensor tendon covering the surface of the bone, as suggested by Prof. Agnew. In effecting reduction the patient should be placed under the influence of an anæsthetic, and extreme flexion of the thigh upon the pelvis produced. An assistant should now alternately flex and extend the leg, while the surgeon places his thumbs on opposite sides of the bone, one below and one above, and makes firm pressure in opposite directions, in this way endeavoring to turn the bone over into place.

Section of the muscle and ligament of the patella should not be resorted to, owing to its want of value as a surgical procedure and the danger of provoking severe inflammation of the knee-joint. Spontaneous reduction has occurred in cases which have resisted manipulative efforts.

The *upward* and *downward* dislocation should be treated in the same manner as fracture of the patella.

Congenital dislocations of the patella have been observed in a number of instances.

TIBIA—KNEE-JOINT—GINGLYMOID ARTICULATION.—This articulation is one of the most perfect in the body, and is formed by the condyles of the femur above, the head of the tibia below, and the patella in front. The femur and the tibia are united by strong ligaments placed both without and within the joint. These ligaments are the anterior, posterior, internal, and two external lateral, connected by a thin, but strong intervening fibrous membrane, which is attached above to the femur, to the upper border and sides of the patella, and to the head of the tibia and interarticular cartilages. Within the articulation are the two crucial or interosseous ligaments, the anterior or external, and the posterior or internal, attached below, in front and behind

the spine of the tibia and to the semi-lunar fibro-cartilages, and above to the inner surface of the external and internal condyles of the femur. The external and internal semi-lunar fibro-cartilages are placed in the concave surfaces on the head of the tibia, being fastened to the bone by the coronary ligaments and to each other by the transverse ligament. The synovial membrane is the largest and most extensive in the body, covering completely the interior of the joint and the structures within it, and forming prolongations which have been designated as the ligamentum mucosum and the ligamenta alaria. The knee-joint is not a true ginglymoid articulation, possessing as it does, in addition to flexion and extension, slight rotation, internal and external, the latter most extensive when the knee is semi-flexed. The intimate relations of the popliteal vessels and nerves to the posterior surface of the joint render them liable to injury in cases of posterior displacements. Owing to the very secure manner in which the bones of the knee-joint are held together by the arrangement of external and internal ligaments, and the support derived on all sides from powerful muscular and tendinous structures, dislocations are comparatively of infrequent occurrence. They may occur in the *forward*, *backward*, *outward*, and *inward* directions. In all forms there is rupture more or less extensive of the ligaments of the joint, associated, in some cases, with laceration of the muscular structures. The dislocation may be complete or incomplete.

Causes.—The causes of dislocations of the knee-joint may be traumatic or pathological. Traumatic displacements are due to violence applied either directly, as in blows upon the thigh or leg, or indirectly, as in falls upon the foot, when the limb is partially flexed or rotated. Lateral luxations are

caused by direct force applied simultaneously to the thigh and leg in opposite directions, as in the passage of the wheel of a wagon over the thigh, the leg being firmly fixed. In pathological dislocations of the knee-joint the destruction of the joint structures permits the muscles to draw the tibia up behind the femur producing the backward luxation.

Symptoms.—The symptoms of the various forms of knee-joint dislocations are very prominent; pain, and immobility, with deformity, are present, the latter distinguishing the different forms.

In the *forward* luxation the tibia is placed, in the *complete* variety, upon the anterior surface of the condyles of the femur (Fig. 215); in the *partial* form, the spine of the tibia rests in the intercondyloid groove. The forcible and wide separation of the articulating surfaces causes rupture of the capsular and anterior crucial ligaments and laceration, partial or complete, of the points of origin of the gastrocnemius and tendon of the biceps muscles. The head of the tendon in front, and the condyles of the femur behind, can be readily felt and distinguished in their abnormal positions. The limb is shortened from an inch and a half to two and a half or three inches, flexed or extended, and the leg is twisted, being rotated either outward or inward. The quadriceps extensor femoris muscle is relaxed, and the patella rests

Fig. 215.

externally leaving a depression over the joint. The leg is flexed and rotated on its axis.

The *inward* luxation is characterized by symptoms which are the reverse of those attending the outward displacement. The head of the tibia is displaced inwardly, so that the internal condyle rests on the spine of the bone or upon either side of it. (Fig. 218.) The joint is increased in

Fig. 217.

Fig. 218.

width, the patella displaced internally, the leg flexed and twisted on its axis. The length of the limb is normal as in the outward variety.

Diagnosis.—When an examination is made before the supervention of much swelling, the displaced condyles of the femur and head of the tibia can be readily outlined, and the nature of the dislocation determined in all of the varieties. The shortening of the limb will distinguish the *forward* and

backward dislocations from the *lateral*, in which the length is normal.

Prognosis.—The very severe injuries inflicted upon the sensitive structures of the joint, especially the extensive synovial membrane, in some forms of dislocation which is liable to be followed by a high grade of inflammation, renders the prognosis doubtful as to the subsequent full restoration of the functions of the joint. More or less weakness is likely to exist for a long time following the accident. In *backward* dislocations complete rupture or laceration of the inner coats of the popliteal artery may occur, leading in the one instance to extensive infiltration of blood into the popliteal space, and, possibly, gangrene of the leg, and in the other to the formation of an aneurism. The nerve trunks are very rarely injured.

Treatment.—In the complete variety of the *forward* and *backward* dislocations, reduction may be effected by placing the patient in the recumbent position upon a firm mattress on the bed, administering an anæsthetic and obtaining counter-extension by a band secured to the thigh and held by an assistant, while extension is made by an another assistant who grasps the leg; while firm and steady extension is made, the surgeon places his knee or forearm behind the joint and forcibly flexes the leg, in this way returning the tibia into place. In the incomplete luxation the surgeon may accomplish reduction by grasping the leg above the ankle, and, hooking the other arm under the knee, flexing the leg forcibly.

In the *lateral* displacements, *outward* and *inward*, reduction can be easily accomplished by making extension and counter-extension and pressing the luxated tibia into place.

The severe inflammation which usually accompanies

knee-joint dislocations requires confinement of the patient in bed after reduction, for three or four weeks, and the employment of such remedies, internally and locally, as will control the morbid action. The limb should be placed in a long fracture box, with the knee slightly flexed and well supported, and dry or moist cold, by means of ice bags or irrigation with ice-water, or cold solutions of laudanum and lead-water should be applied over the joint. If necessary local depletion may be obtained by leeches, and mercurial purgatives may be administered. Pain should be allayed by anodynes. When the inflammation has subsided and the reparative process has sufficiently progressed, at the expiration usually of two and a half to three weeks, gentle movements should be made to prevent anchylosis. After release from bed the patient should walk with the aid of crutches, placing no weight upon the injured limb until two months have elapsed since the receipt of the injury. Support should be afforded to the joint by an elastic cap and friction should be made with stimulating liniments.

Complicated dislocations of the knee-joint are very grave accidents. The complications may consist in fracture of the tuberosities or head of the tibia, or rupture of the popliteal artery. In fracture, replacement of the fragment may occur in effecting reduction of the dislocation. If this does not occur it should be pressed into place after return of the displaced tibia. The treatment should be that advised in fractures involving the knee-joint on page 257. Rupture of the popliteal artery, the existence of which is recognized by the sudden occurrence of swelling in the popliteal space, with cessation of pulsation in the tibial arteries and coldness of the leg, demands immediate amputation.

Compound dislocations of the knee-joint require in their

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movements of the tibia, and in this way it becomes impacted between the articulating surfaces of the condyle of the femur and the head of the tibia. The internal cartilage is the one most frequently displaced, an occurrence possibly due to its less firm attachments. The accident occurs usually in persons of delicate health, and is caused by a sudden and forcible twist of the joint or slip of the foot with rotation inward of the leg, the thigh at the time being fixed or rotated outward.

The *symptoms* are very characteristic, the occurrence of the displacement being attended with a sudden faintness, intense pain in the joint, and an inability to stand or walk. The pressure upon the displaced cartilage causes intense pain and shock; swelling soon appears, indicating the collection of fluid in the joint due to pressure and the accession of inflammation of the synovial membrane.

The *diagnosis* is made by careful examination of the joint and inquiry as to the manner in which the injury was received. The sudden occurrence of faintness, pain, and impairment of the functions of the joint will direct attention to the nature of the displacement.

The *prognosis* is favorable, reduction being usually easily accomplished and the functions of the joint unimpaired. In most cases there remains a tendency to recurrence of the displacement, which may be overcome by the exercise of caution on the part of the patient in the execution of strong and sudden flexion of the knee.

The *treatment* consists in reducing the displaced cartilage and supporting the joint for some time with a bandage or elastic cap. In accomplishing reduction the patient should be placed in the recumbent position, and an anæsthetic administered. The surgeon having fixed the thigh upon the

ɔs and the maintenance of the limb in the flexed position for three or four weeks until union of the ligaments ırs. A plaster or silicate bandage may be applied to the and leg, carrying it to the middle of the thigh so as to ıobolize the limb and keep the displaced bone in place. *ubluxation*, occurring in persons of feeble health, and due relaxed condition of the ligaments, should be treated by administration of tonics, and the repeated applications of nter-irritants, as tincture of iodine, or vesication with ll blisters. In some cases it may be necessary to excite ımmatory action in and about the articulation by scarifions made with a delicate tenotome introduced subcutanısly.

NFERIOR TIBIO-FIBULAR ARTICULATION—ARTHROL ARTICULATION.—The tibia and fibula enter into the ıation of this joint by rough triangular convex facets on outer and inner surfaces respectively of their lower ends. y are united by the interosseous, anterior and posterior rior tibio-fibular, with the transverse ligaments, the synl membrane being derived from the ankle-joint. Very ht gliding of the surfaces upon each other is the only ement permitted in this articulation. Dislocation of joint, as an independent lesion, is a very rare occurrence, when it occurs, it is in the backward direction. One case corded by Boyer in which simultaneous dislocation of ı superior and inferior articulations occurred.

he *cause* of displacement at this joint is great violence ctly applied, as may happen in falls from a height, upon foot.

he *symptoms* are pain, deformity, and loss of function. lling is liable to follow soon upon receipt of the injury. he *diagnosis* is made by careful examination of the

part, by which the position of the displaced bone may be determined, providing much swelling has not occurred.

Treatment.—Replacement of the dislocated fibula may be accomplished by extending the leg so as to relax the peroneus longus and brevis muscles which run in a groove on the posterior border of the bone and pressing the end forward into place. A figure-of-8 bandage of the leg and foot should be applied, and the limb should be kept quiet in a fracture-box for a period of three or four weeks. Passive motion and frictions should be employed to overcome stiffness of the ankle-joint.

TIBIA, FIBULA, AND ASTRAGALUS—ANKLE-JOINT—GINGLYMOID ARTICULATION.—The ankle-joint is formed by the lower end of the tibia and the internal malleolus, the external malleolus of the fibula, and the upper convex surface of the astragalus with its two lateral facets. The union of the articular surfaces of the tibia and fibula forms an arch in which the astragalus is received. The ligaments are the internal and external lateral, with a thin membranous layer in front called the anterior ligament. A similar layer is placed posteriorly, forming with the other ligaments an imperfect capsule of the joint. The synovial membrane lines the interior of the joint. The ankle is a true hinge-joint, possessing flexion and extension without lateral movement. In dislocation of the ankle-joint the foot is displaced anteriorly, forming the *forward*, posteriorly, the *backward*, and laterally, the *outward* and *inward* varieties of dislocation. The great strength of this joint makes dislocation a rare occurrence.

Causes.—Luxations of the ankle-joint are the result of great violence applied directly, as blows upon the front of the leg, producing *forward* displacement of the foot or a

[redacted]

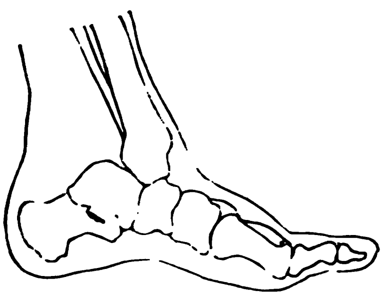
fall upon the heel, the leg being fixed, the foot strongly flexed; blows upon the back of the leg, the foot being fixed will project the tibia and fibula forward, producing a *backward* displacement of the foot. *Lateral* dislocations are caused by force indirectly applied, as in falls upon either side of the foot, producing violent abduction or adduction.

Symptoms.—The chief symptom of dislocation of the ankle-joint is deformity caused by the displacement of the foot.

In the complete *forward* luxation the ligaments are torn and the astragalus rests in front of the tibia forming a distinct prominence. (Fig. 219.) In the incomplete variety, the astragalus is but slightly separated from the articulation. The foot is lengthened and the heel markedly shortened. The tendo Achillis lies close in contact with the posterior surface of the tibia; the function of the foot is impaired, especially as regards flexion. In *partial* luxation the symptoms are much less prominent.

Fig. 219.

Fig. 220.



The complete *backward* dislocation of the ankle-joint, in addition to the rupture of all of the ligaments, is frequently accompanied by fracture of the fibula and in some instances by fracture of both tibia and fibula. The tibia and fibula rest upon the scaphoid and cuboid bones in the complete luxation (Fig. 220); in the incomplete form, the tibia rests upon the head of the astragalus and the fibula upon the greater process of the os calcis. The symptoms of the backward displacement are shortening of the foot with lengthening and elevation of the heel. The tendo Achillis is removed from the posterior surface of the leg, and is very prominent. The toes are flexed, and the tibia can be readily felt in its abnormal situation.

In the *outward* dislocation the internal lateral ligament is ruptured, and in some instances the internal malleolus. The pressure exerted upon the external malleolus at the time of dislocation is frequently sufficient to fracture the fibula some distance above, producing that form known as Pott's fracture. (Fig. 221.) The deformity is characteristic; the internal malleolus is very prominent and the foot rests upon the inner surface in a state of marked eversion. (Fig. 222.) The point of fracture of the fibula can be distinguished by the depression above the external malleolus and by the crepitus, which can be elicited on making movements of adduction and abduction.

In the *inward* luxation the external lateral ligament is torn and the foot is inverted, resting upon the outer border. The external malleolus can be felt as it projects beneath the tissues; fracture of the fibula frequently accompanies this form of dislocation.

Dislocation *upward*, in which variety the astragalus is forced upward between the tibia and fibula, is a very rare

accident. In one form of this luxation the fibula is fractured and widely separated from the tibia. The projection down-

Fig. 221.

Fig. 222.

ward of both malleoli, sometimes reaching to the sole of the foot, with the great increase in the breadth of the ankle and the separation of the tibia and fibula, constitute the symptoms of this variety of ankle-joint dislocation.

Diagnosis.—The diagnosis in the various forms of dislocation of the ankle-joint is made by a careful examination of the parts. The displacemen in each variety is characteristic, and can be usually easily recognized on examination. Fracture, complicating the injury, can be distinguished by crepitus and mobility. In the uncomplicated dislocation immobility is a prominent symptom.

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wound of the soft structures is caused by a protrusion of the internal malleolus. (Fig. 223.)

The *symptoms* are unmistakable, and the *diagnosis* is easily made made by an examination of the parts. The *prognosis* is doubtful, fatal results having followed in many cases reported, and disability in the event of recovery from the accident.

Fig. 223.

The *treatment* consists, either in immediate amputation or an attempt to save the foot, with or without excision of the malleolus. In this injury as in compound dislocation of the knee-joint, the most careful consideration on the part of the surgeon is demanded. While statistics show that formerly the best results followed immediate amputation, it is believed that the antiseptic methods of wound treatment now enable the surgeon to accomplish results equally good and with the preservation of the foot. If the injury is very severe, the tissues extensively lacerated, and the bones comminuted, amputation should be performed. In cases of less severity, when the tibia protrudes through the wound, excision should be performed and the wound treated antiseptically. When the tibia does not protrude excision should not be practised.

Tarsus—Tarsal Articulations—Arthrodial and Enarthrodial Articulations.—The tarsal articulations are divided, as those of the carpus, into three sets; first, that

of the first row of tarsal bones; second, those of the second row, and third, those of the two rows with each other. The first row, consisting of the os calcis and astragalus, is united by three ligaments, the *external calcaneo-astragaloid*, the *posterior calcaneo-astragaloid*, and *interosseous*. The second row, composed of the scaphoid, cuboid, and three cuneiform bones, is connected by three ligaments, the *dorsal*, *plantar*, and *four interosseous*. The two rows are joined by three sets of ligaments, those between the os calcis and cuboid, four in number, two dorsal, the *superior calcaneo-cuboid*, and the *inferior calcaneo-cuboid* or *interosseous*, and two plantar, the *long* and *short calcaneo-cuboid;* those between the os calcis and scaphoid, two in number, the *superior and inferior calcaneo-scaphoid*, and that between the astragalus and scaphoid, the *astragalo-scaphoid*. Four synovial membranes are placed between the surfaces of adjacent tarsal bones and the second and third metatarsal, while the articulation between the internal cuneiform and first metatarsal and cuboid and fourth and fifth metatarsal bones, are lined by separate sacs. (Fig. 224.)

Fig. 224.

A gliding movement from before backward, and from side to side, occurs between the os calcis and astragalus. A slight movement of the same character takes place between the scaphoid, cuboid, and cuneiform bones. The articulations between the astragalus and scaphoid, and os calcis and cuboid being enarthrodial in character, permit a degree of rotation, by means of which the sole of the foot may be slightly flexed or extended, or carried inward and outward. The secure manner in which the different bones of the tarsus are fastened together, and the astragalus to the bones of the leg, renders their separation, as an uncomplicated injury, a very rare occurrence. Of the different bones of the tarsus, the astragalus, owing to its position and relations, is more liable to suffer from luxation than the others. Dislocations of the os calcis, scaphoid, cuboid, and cuneiform bones are extremely rare accidents, especially when they occur as uncomplicated luxations.

Causes.—The bones of the tarsus require for their dislodgment the application of extreme force, as in falls from a height, the foot being violently twisted or turned.

ASTRAGALUS.—Dislocations of the astragalus may occur in the *forward*, *backward*, and *lateral* directions. The displacement may be *complete or incomplete.*

In the *complete forward* dislocation the astragalus is forced from its normal position and articulations, and placed in front of the tibia, upon the scaphoid, or as far forward as the cuneiform bones. In the *incomplete* variety the head of the bone may be separated from the articulation with the scaphoid and rest upon it. The degree of anterior displacement varies in the incomplete form.

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Diagnosis.—In the
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ported in which reduction was not effected, the functions of the foot were ultimately restored to a great extent.

Treatment.—Owing to the twisted position assumed by the astragalus at the time of its displacement and the firm manner in which the bone is locked in its abnormal situation, reduction in the *forward* dislocation is often extremely difficult and in the *backward* form impossible, having been effected in this variety in but one case thus far reported, and in that, there was associated with the dislocation fracture of both tibia and fibula which, without doubt, removed the rigidity of the parts and facilitated replacement. Notwithstanding the unfavorable prognosis as to reduction in these cases, efforts should always be made, however, to effect it. It is of the utmost importance that the efforts should be made with great discretion lest untoward results attend them. Violent and prolonged attempts are liable to excite undue inflammation and cause sloughing of the tightly stretched integument overlying the displaced bone. If efforts made in the proper manner and for a suitable period of time are unavailing, subcutaneous section of resisting muscular and tendinous structures should be made with a view to facilitate replacement. Chief among these structures is the tendo Achillis, section of which may alone be efficient. If, even after the adoption of these measures reduction is not accomplished, the tension of the parts should be relieved by subcutaneous incisions to overcome the tendency to sloughing of the integument. In cases of complete dislocation of the bone where it lies loose beneath the integument and muscles of the dorsum of the foot, excision should be performed at once. The descent of the tibia upon the articulating surface of the os calcis renders the replacement in these cases impossible.

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its connection with the tibia and fibula being undisturbed. The direction of the displacement may be the same as that taken by the astragalus when dislocated independently, as *forward*, *backward*, *outward*, and *inward*.

The *symptoms* are very prominent, chief among them being deformity which is marked and characteristic. The dislocation is to be distinguished from that of the astragalus, which may be done by noting that the relations between the tibia and fibula remain undisturbed.

The *prognosis* is doubtful owing to the injury necessarily inflicted upon the soft parts at the time of the displacement, and the great difficulty in effecting reduction.

The *treatment* consists in efforts to replace the displaced bone by extension and counter-extension, with manipulation and pressure as in dislocation of the astragalus. Subcutaneous section of the tendo Achillis and tendons of the tibialis anticus and posticus, or other muscles, should be performed if the ordinary methods of reduction fail. If all means fail in accomplishing replacement the displaced bone may be allowed to remain in its abnormal position with the expectation that the recovery may ensue with disability, but with a limb not entirely devoid of service. If unfavorable symptoms should arise, excision of the bone, or amputation by Pirogoff or Syme's method should be performed.

Compound dislocations of the astragalus demand immediate excision of the bone or amputation of the foot, as may be deemed best.

In *simple* dislocations of the astragalus the leg should be placed in a fracture box after reduction or after unsuccessful efforts at reduction have been made, and applications of laudanum and lead-water should be applied. If the inflammation is severe, local depletion by leeches may be resorted

to and mercurial purgatives administered. Passive motion should be employed at an early period to prevent anchylosis.

Anomalous dislocations of the astragalus have from time to time, been reported. The cases reported include displacement in all directions; the most remarkable among them being the complete reversal of the position of the bone, the head looking toward the tendo Achillis and the posterior surface in contact with the scaphoid bone.

Os Calcis.—Dislocation *outward* of the os calcis, involving a separation, partial or complete, from its articulation with the cuboid may occur.

The condition may be recognized by the prominence afforded by the displaced anterior surface of the bone on the outside of the foot, and the inability of the patient to rotate the foot inward or outward owing to the interference with the medio-tarsal articulation.

Reduction may be obtained by extension, the surgeon grasping the instep and heel while an assistant makes counter-extension from the leg, which is in the flexed position, and the bone is pressed into its place. Extension of the foot, while abduction and adduction with pressure are made, may also effect reduction.

Scaphoid.—A few cases of luxation of this bone have been recorded. It may be displaced *inward* or *upward*, the former direction being the most common. The position of the displaced bone will determine the nature of the accident as well as the bone involved. Reduction may be effected by making extension from the foot, and pressure upon the bone.

Cuboid.—Dislocation of the cuboid alone is a very rare accident, and its occurrence is doubted. Instances of the

separation of both *scaphoid* and *cuboid* from the astragalus and os calcis are recorded. In the event of an independent luxation of the cuboid, the nature of the displacement could be readily determined by careful examination. Reduction may be accomplished by extension, with abduction and adduction and pressure upon the displaced bone.

CUNEIFORM BONES.—Dislocation of the cuneiform bones is rare. The internal is most frequently dislocated; sometimes all are partially displaced. In luxation of the internal cuneiform, the displacement is inward and a marked prominence exists upon the inner and upper aspect of the foot. When two or all are dislocated the displacement is chiefly upward. Reduction is effected by extension and counter-extension with abduction, so as to separate the metatarsal bone of the great toe and the scaphoid, and give space for replacement of the bone by pressure.

After reduction in dislocations of the os calcis, scaphoid, cuboid, and cuneiform bones, compresses should be placed over the replaced bone and held in position by a roller. The leg should be supported in a fracture box or between bags of sand for two or more weeks. At first the patient should walk with the aid of crutches in order to relieve the weight upon the foot.

METATARSUS — TARSO-METATARSAL JOINTS — ARTHRODIAL ARTICULATIONS.—The tarso-metatarsal articulations are formed by the anterior surfaces of the three cuneiform bones and the cuboid, and the bases of the five metatarsal bones. The articular surfaces of the different tarsal and metatarsal bones differ in shape, that of the internal cuneiform and first metatarsal being *reniform* or *kidney*-shaped, while those of the remaining cuneiform, the cuboid and metatarsal bones, are *triangular*, the inner facets

between the first and second row and second and third row of the phalanges of the toes. The ligaments of the joints are the same as those of fingers, anterior and two lateral The movements of the joints are limited to flexion and extension. Dislocations of the phalanges of the foot are more infrequent than those of the hand. They may occur at the metatarso-phalangeal or in the phalangeal articulations; they are most frequent between the first row and the metatarsal bones. Displacement of the great toe takes place more frequently than that of any of the others. Separation of all of the toes at the metatarso-phalangeal articulation has occurred in one reported case.

The *cause* of luxation at either the junction with the metatarsal bones or between the phalanges, is violence applied in falls, twists, or blows. They occur sometimes as the result of the toe coming in contact with a fixed object, as a displaced brick or flagging in the pavement, the toe being stumped against the object.

The chief *symptom* is deformity, exhibited in the shortening and flexion, or extension, with abduction or adduction of the toe. Pain is sometimes marked, the prominence formed by the displaced bone is usually easily recognized.

The *diagnosis* is generally made without difficulty. In dislocations of the great toe at the metatarso-phalangeal junction, difficulty may be experienced in effecting reduction, rendering the prognosis doubtful in these cases. In unrelaxed luxations the impairment of function is usually not great.

The *treatment* consists in replacing the bone by extension combined with pressure. Flexion and extension of the toe may facilitate reduction. In cases which resist reduction by the usual methods of traction, full extension of the toe

may be made upon the metatarsal bone and pressure exerted against its base, as practised in dislocations of the thumb. After reduction, in dislocation of the bones of the metatarsus or phalanges, the foot should be surrounded with a suitable bandage and placed at rest in a fracture box or between bags of sand. It may be necessary, in some instances, where there is a tendency to recurrence of the displacement to apply a splint to the plantar surface and hold it in position with a bandage.

In *compound* dislocation of the toes excision or amputation should be performed. In cases also in which the displaced bone cannot be reduced, and it gives rise to great deformity with pain in walking, excision or amputation is demanded.

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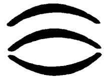
The *curvilinear incision* (Fig

Fig. 229.

Fig. 230.



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not at the wrist or elbow-joint. Very long incisions may require a sweeping movement made with the entire arm. In cutting from without inward, the edge of the knife should be held lightly in contact with the surface, not pressed into the tissues. "Dexterity, grace, and elegance," in using the knife, can be acquired only by practice and careful study.

Closure of Wounds.—In order to retain the edges of wounds in close apposition, so that union may take place, the introduction of sutures is necessary.

The Sutures.—The material used may be silk or linen, animal tissue or metal. The metallic suture may be made of silver, iron, or lead-wire. The suture may be fastened by a square knot, or, as in the metallic suture, by twisting the ends or clamping shot upon them. When the metallic suture is used in a cavity, as the mouth or vagina, the cut ends can be covered by clamping a shot on them, so as to prevent them from penetrating the tissues, and thus causing pain. The knots or twisted ends should always be placed on the *side* of the incision, and not *over* it.

The principal forms of sutures employed are the INTERRUPTED, the CONTINUED, the TWISTED, and the QUILLED.

The *interrupted*, *continued*, and *quilled* sutures are made by the insertion of a needle armed with a thread made of silk, linen, or wire.

In the *interrupted suture* (Figs. 232, 233) the needle is carried through the edge of the wound from without inward, at a proper distance from the border, across the wound, and pushed from within outward at exactly the same point on the opposite side. The thread is then cut, and another suture introduced either above or below. They may be superficial or deep (Fig. 234).

Fig. 24.

Fi

ber of sutures have been introduced to hold the edges in apposition.

The *quilled suture* (Fig. 236) is formed by passing through the lips of the wound a needle armed with a

Fig. 237.

Fig. 238.

double thread. The ends of the thread are tied over pieces of quill, bougie, or light wood, placed parallel to the edge of the incision. This suture, as well as the beaded suture (Fig. 237), is employed in approximating the edges of deep wounds.

The *twisted suture* (Fig. 238) is made by introducing a pin made of steel, commonly called the hare-lip pin, through the edges of the wound, and carrying a thread round it in an *elliptical* manner, so as to hold it in place. The pin is passed through the deeper parts of the wound, approximating them, while the thread brings the superficial portions in contact.

Needles.—The needles employed to pass the threads in forming sutures may be either straight or curved, round,

Fig. 239.

triangular, or double-edged (Fig. 239). They may be mounted on handles (Fig. 240), and may be cannulated (Fig. 241), and provided with special appliances for facilitating the passage of thread or wire. In using the needles with handles they should be passed through the tissues, then threaded and withdrawn.

Fig. 240.

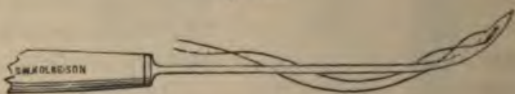
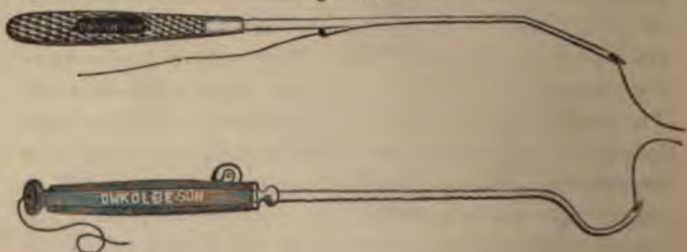


Fig. 241.



OPERATIONS UPON THE LIVING AND DEAD SUBJECTS.

As the knowledge of the surgeon is to be acquired in operations performed upon the dead subject, it is important

for him to understand that a marked difference exists with regard to the character of the tissues and the manner in which they separate under the edge of the knife in the living and the dead subjects. This difference should be carefully noted, so that when he undertakes operations upon the living subject he may avoid errors.

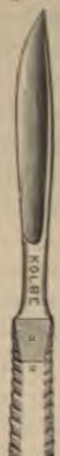
In the living subject the soft tissues possess a great amount of elasticity and power of contractility. The former property resides to a marked degree in the common integument, and thus adapts it in an admirable manner to the purposes of a common covering of the body. In the muscular structures the power of contractility is very great, varying, of course, in proportion to the size and amount of tissue involved.

In the dead subject these conditions are entirely absent; it is true that in the recently dead subject a small amount may exist, but it may, however, be regarded as practically wanting. In the subject which has been injected with such an agent as chloride of zinc, and kept for a period of time in a solution of salt, elasticity and contractility of the tissues are not only absent, but there exists, in fact, as a result of this method of preservation, an induration which is altogether unnatural, and which impairs to a great degree the value of the subject for anatomical or surgical purposes. The color and appearance of the tissues as well as the texture are altered, so that these cannot be taken as guides in recognizing different structures. In the living subject a very slight exertion will carry a sharp knife easily and smoothly through the tissues—almost, it may be said, to glide through without any effort on the part of the operator. In the dead subject, on the contrary, an effort is required to pass the knife through the structures, and in a subject

prepared as above described, some force is necessary to divide them. The resistance offered by the tissues of the dead subject is well shown in the effort to introduce the catheter in the cadaver. Sometimes it is impossible to accomplish it, and even when done it has required so much force as to inflict injury upon the parts. The information derived from the operation is therefore of little practical value, since in the living subject the instrument is simply guided through the canal, passing almost by its own weight. The surgeon will find, therefore, in passing from operations upon the dead to those upon the living subject, that unless he exercises great caution he will overestimate the resistance of the tissues and fail to make his incisions as contemplated.

INSTRUMENTS USED IN THE LIGATURE OF ARTERIES.

Fig. 242.



Instruments.—The instruments required to perform operations for the application of ligatures to arteries, are :—

1. *A knife.*—That known as the scalpel, an instrument having a sharp point and a broad body or belly (Fig. 242).

2. *A pair of dissecting forceps* (Fig. 243) to seize and hold the tissues, as may be necessary, in their division. The forceps should be held between the thumb and index and middle fingers.

3. *A grooved director.*—A blunt-pointed director, from four and a half to five inches in length, with a groove upon its upper surface (Fig. 244). It is used to introduce beneath layers of tissue before dividing them,

and also to separate the delicate fascia enveloping vessels.

4. *A ligature needle.*—A curved, blunt-pointed needle having an eye near its point, and mounted in a handle so as to enable it to be conveniently carried round the artery (Fig. 245).

Fig. 243.

Fig. 244.

Fig. 245.

Fig. 246.

5. *Ligatures.*—Threads made of various materials; silk, flax, animal tissue, or metal. They should be cut from fourteen to eighteen inches in length.

6. *Retractors.*—Instruments formed from metal, curved at

one extremity, and of sufficient length and breadth to hold conveniently the edges of the wound apart (Fig. 246).

7. *Scissors.*—The ordinary straight surgical scissors.

8. *Suture needles.*

9. *Sutures.*

In performing the operation upon the living subject, there would be needed, in addition, adhesive plaster, cut into strips, to support the edges of the wound, a compress to cover the surface of the wound, and a roller to confine the dressings and afford gentle support to the parts.

OPERATIONS FOR THE LIGATURE OF ARTERIES.

General Considerations.—In order to perform the operation for the ligature of arteries properly, it is essential that the surgeon should have a thorough knowledge of the anatomical relations of the structures concerned in the operation. He should be able, as it were, to see through the parts—to have a mental picture of the structures, layer after layer, from the surface to the position occupied by the vessel. He should have such familiarity with the appearance of the various tissues as will enable him to distinguish them promptly—their color and the arrangement of their fibres. He should know so well the course of the vessel that he can make the incision directly over and parallel to it, and not across it. He should not commence the incision by hunting for the artery, but should proceed intelligently, seeking as he advances for well-known and well-established guides or landmarks, structures of importance and having important relations to the vessel he seeks.

The student, in operating upon the cadaver, is especially

cautioned against want of care and undue haste; it is too frequently observed that many are satisfied with simply finding the vessel, without possessing any definite knowledge with regard to its position and relations. As a result of such imperfect methods it not infrequently happens that the ligature is found to surround a vein, nerve, tendon, or even a portion of muscular tissue or fascia, instead of the artery.

Every operation performed for the ligature of an artery can be divided into three well-defined stages. The first stage embraces that part of the operation which relates to reaching or exposing the artery or its sheath; the second includes the isolation or separation of the artery from the surrounding or accompanying structures; in the third, the operation is completed by the application of the ligature and the closure of the wound. It is in the first stage of the operation that the anatomical knowledge of the operator is especially to be brought into play. He should carefully inspect the limb or part so as to fix the important external landmarks or surface markings; he should also feel it, so as to determine the nature of the structures causing projections upon the surfaces. He should fix accurately the points between which the vessel passes, and define its course; he should recall its general relations in its entire extent, and its particular relations at the point of ligation. He should note carefully the character of the structures having particular relations, whether bloodvessels or nerves, and therefore to be approached with great caution, or muscles or tendons which serve as rallying points or guides. After the incision of the skin and superficial fascia has been made, these guides should be sought for in order until the vessel is reached.

be divided in this manner until the sheath of the artery is reached. This is opened by seizing it with the forceps and making a slight nick, of sufficient size, to admit the point of the ligature needle. Through this opening the point of the grooved director is inserted, and the artery is gently and cautiously separated from the sheath and the accompanying structures. The ligature needle, having been armed, is now introduced through the opening, the point kept in close contact with the artery and carried around it in a direction from the vein or nerve, and brought out on the opposite side. One thread of the ligature is now seized with the forceps, and held firmly while the needle is withdrawn.

The artery thus surrounded should be raised gently from its bed, and examined to see that no other structure is included in the ligature. This being determined the ligature is tied, as shown in Fig. 248, with a square or reef knot (Fig. 249), or surgeon's knot (Fig. 250), care being taken to

Fig. 249.

Fig. 250.

avoid making the "granny" knot, which is liable to slip (Fig. 251); one end is cut off close to the knot, and the remaining one is allowed to pass directly out of the wound.

The wound is now closed by two or more sutures, the

knots being placed on one side of the incision and not over it, adhesive strips and compress are applied, and the parts gently supported by a few turns of the roller.

Fig. 251.

Some of the more important points relating to the different steps of the operation may be embraced in a few general rules, which will assist the surgeon in fixing them upon his mind.

I. Make the incision directly over and parallel to the course of the artery, not across it. Unless the incision is made very wide of the course of the vessel, this plan will give ample room. The tissues can be separated by the retractors, so as to increase the space, when required. If the oblique incision is made, and is carried into the deeper part of the wound, the muscular structures would be divided across their fibres, which is objectionable, and not parallel with them.

II. Dissect directly down to the artery. Avoid lateral dissections and disturbance of the surrounding structures.

III. Separate the artery from its sheath to the slightest extent possible.

IV. Do not use the point of the knife in the wound after the sheath of the vessel has been reached and opened. Use the handle of the knife and the grooved director to separate tissues.

V. Always pass the ligature from the vein, if present.

VI. Make the incision as small as possible, but always large enough to give ample working space and light. The external incision should be made to the extent required by

be divided in this manner until the sheath of the artery is reached. This is opened by seizing it with the forceps and making a slight nick, of sufficient size, to admit the point of the ligature needle. Through this opening the point of the grooved director is inserted, and the artery is gently and cautiously separated from the sheath and the accompanying structures. The ligature needle, having been armed, is now introduced through the opening, the point kept in close contact with the artery and carried around it in a direction from the vein or nerve, and brought out on the opposite side. One thread of the ligature is now seized with the foroeps, and held firmly while the needle is withdrawn.

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Fig. 249.

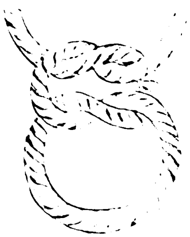
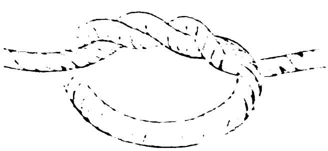


Fig. 250.



avoid making the "granny" knot, which is liable to slip (Fig. 251); one end is cut off close to the knot, and the remaining one is allowed to pass directly out of the wound.

The wound is now closed by two or more sutures, the

the *first* stroke of the knife, so as to avoid subsequent incisions to enlarge it. These, when made, usually result in the production of irregular, jagged edges. A superficial artery requires a short incision, one lying deeper a longer incision.

VII. In closing the wound, the needle should be inserted at such distance and depth from the edge as to resist tension—as a rule, not less than half a line, nor more than a quarter of an inch. Two-thirds of the thickness of the edge should be supported by the suture.

In describing the application of ligatures to the various arteries, a plan has been adopted which, it is thought, will assist the surgeon materially, not only in performing the operations, but in studying them. An effort has been made to present the subject in a systematic manner, so that when the operation is undertaken he will find information which will enable him to proceed intelligently through each step, and, when finished, study it as a complete operation.

In each description the following order has been observed :—

I. The course of the vessel is stated, the direction which it takes in passing between certain points—fixed or imaginary.

II. External guides or surface markings are given. These may exist as bony projections or borders of muscles which appear prominently upon the surface ; they are important in fixing the relations of the vessel to the external surface.

III. The general anatomical relations which the vessel has are given in detail, and also the particular relations at the point of application of the ligature. These acquaint the

surgeon with the entire surroundings of the vessel, informing him of their nature.

IV. Internal guides, landmarks, or rallying points, which are to be sought for as the operation progresses, are noted in each case.

V. Certain structures, as veins and nerves, have relations to each important artery, and are to be carefully avoided. These are stated in the order of their importance, and in certain operations special attention is directed to their presence.

VI. Some of the larger arteries are embraced in a common sheath with the vein, and sometimes a nerve. When this arrangement exists it is stated.

LIGATURE OF SPECIAL ARTERIES.

The Innominate Artery.—Surgical Anatomy.—Before attempting to ligate this vessel the surgeon should endeavor to obtain a clear idea of the relations it has to the

Fig. 252.

1, 1. Internal jugular veins.
2, 2. Subclavian veins.
3. Right innominate vein.
4. Left innominate vein.
5. Inferior thyroid vein.
6. External jugular vein.
7. Arch of the aorta.
8. Innominate artery.
9, 9. Common carotid arteries.
10, 10. Subclavian arteries.

Innominate Artery.

very important structures which surround it. It is the largest branch given off from the arch of the aorta, and is from an inch and a half to two inches in length (Fig. 252).

Its point of origin, from the transverse portion of the aorta, is about one inch below the margin of the sternum, and on a line with the second costo-sternal articulation. It is in intimate relation with the two large venous trunks—the right and left innominate veins—the right inferior thyroid vein crossing its front in an oblique direction. On the right side it has in close proximity the right pneumogastric nerve and the pleura; it rests upon the trachea, and to the left has in relation the left carotid artery. It will be observed, therefore, that on all sides are placed the most important structures, which require the utmost care to avoid. Not only should these structures be carefully guarded against injury, but in any operation which is performed they should be disturbed to the slightest extent possible. The causes of failure in efforts which have been made to surround this vessel with a ligature in the living subject are stated to have been repeated secondary hemorrhages and inflammation of the pleura and lung.

Course.—Obliquely upward from point of origin from the commencement of the transverse portion of the arch of the aorta to the sterno-clavicular articulation of the right side.

Surface markings.—Sterno-clavicular articulation. Fossa above the clavicle, indicating the interval between the two heads of the sterno-cleido-mastoid muscle.

General relations.—In front.—Sternum, sterno-hyoid, and sterno-thyroid muscles; remains of thymus gland; left innominate and right inferior thyroid veins, and cardiac branches of the right pneumogastric nerve.

Behind.—The trachea.

Right side.—Right innominate vein, pneumogastric nerve, and the right pleura.

Left side.—Remains of the thymus gland and the left carotid artery.

Guide.—The sterno-cleido-mastoid muscle.

Structures to be avoided.—The middle and right inferior thyroid, the anterior and internal jugular, and the right innominate veins; the pneumogastric nerve.

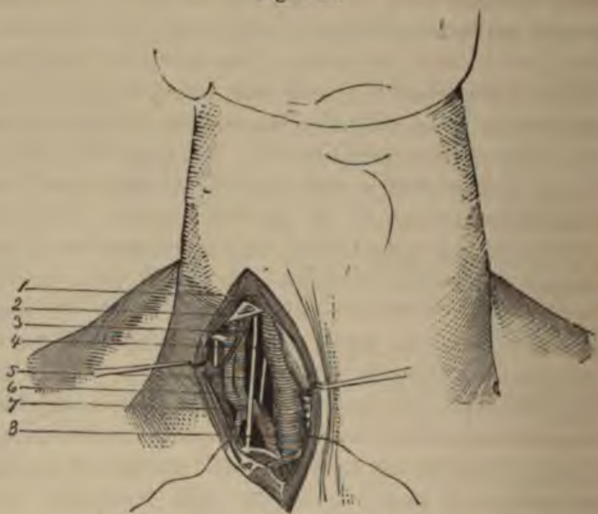
Operation.—Raising the shoulders, inclining the head slightly backward and to the left side, so as to render tense the right sterno-mastoid muscle, and project the innominate artery into the neck, an incision, three inches in length, dividing the skin, should be made from below the clavicle upward over the fossa, indicating the interval between the two heads of the sterno-mastoid muscle. The superficial fascia, platysma myoides, and anterior layer of the deep fascia, are now carefully divided on the grooved director. Flex the head slightly, and separate with the fingers the heads of the sterno-mastoid muscle, the connecting areolar tissue having been divided. Divide carefully on the director the deep layers of the cervical fascia, and, if necessary, the sterno-hyoid and sterno-thyroid muscles transversely. These incisions will expose the point of bifurcation of the artery into the carotid and subclavian arteries. Passing downward from this point the artery can be reached, and the ligature applied from *right* to *left*, so as to avoid the right innominate vein (Fig. 253).

The innominate artery can also be reached by an incision, two inches in length, made along the anterior border of the sterno-mastoid muscle, terminating at the clavicle. From this point a second incision, to the same extent, is carried along the upper border of the clavicle. The points of attachment of the platysma, the sterno-mastoid, sterno-thyroid, and sterno-hyoid muscles are to be divided

as they are exposed. Dividing carefully the fascia, and separating other structures, the right carotid artery is brought into view; tracing this downward, the innominate artery can be reached and ligatured.

The advantages claimed for the method first described are, in avoiding the section of the muscles, and the greater

Fig. 253.



1. Internal head of sterno-mastoid muscle.
2. External head of sterno-mastoid muscle.
3. Vertebral artery.
4. Pneumogastric nerve.
5. Recurrent laryngeal nerve.
6. Internal jugular vein pulled aside.
7. First part of subclavian artery and its branches.
8. Innominate artery.

ease with which the artery is approached. While, in all cases, it is desirable to divide the tissues to as slight an ex-

tent as possible, it is, nevertheless, of great importance that the operator should not be embarrassed by want of ample working space. Great injuries may be inflicted upon structures in the effort to save those of less importance. In this operation it is sometimes impossible to avoid wounding some of the larger venous branches in relation with the artery; when this occurs they should be ligated, or, when it is necessary to divide them, two ligatures should be applied, and the vein cut between.

The Triangles of the Neck.—Before passing to the operations upon the arteries which occupy the region of the

Fig. 254.

1. Posterior belly of the digastric muscle.
2. Anterior belly of the digastric.
3. Anterior belly of the omohyoid muscle.
4. Posterior belly of the omohyoid.
5. Sterno-cleido-mastoid muscle.
6. Traperius muscle.

a. Digastric, or submaxillary triangle.
b. Superior carotid triangle, or triangle of election.
c. Inferior carotid triangle, or triangle of necessity.
d. Occipital triangle.
e. Subclavian triangle.

Triangles of the Neck.

neck, the surgeon should, in connection with the study of their relative anatomy, also carefully examine these structures collectively. On examination it will be found that

these vessels, with other important structures, occupy certain well-defined spaces, which can be readily outlined, and which are formed by prominent muscular and bony structures (Fig. 254). The side of the neck is somewhat quadrilateral in shape; bounded above by the lower border of the body of the jaw and an imaginary line extending from the angle of the jaw to the mastoid process of the temporal bone; below, by the upper border of the clavicle; in front, by the median line of the neck; and behind, by the border of the trapezius muscle. The sterno-mastoid muscle, crossing this space obliquely, divides it into two large triangles, the anterior and posterior. The former is bounded by the median line of the neck in front, the anterior border of the sterno-mastoid behind, and the border of the jaw and the imaginary line from the angle to the mastoid process above. This triangle is subdivided by the digastric and anterior belly of the omo-hyoid muscle into three smaller triangular spaces, named, from below upward, the inferior carotid, the superior carotid, and the digastric.

The inferior carotid triangle, or the "*triangle of necessity*," as it is sometimes designated, is formed by the median line of the neck in front, by the anterior border of the sterno-mastoid behind, and by the anterior belly of the omo-hyoid above. The common carotid artery passes through this space obliquely upward and backward, following the direction of the sterno-mastoid muscle, covered in part by the muscles which take origin from the sternum and clavicle.

The superior carotid triangle, or the "*triangle of election*," is bounded by the posterior belly of the digastric above, the anterior belly of the omo-hyoid below, and the anterior margin of the sterno-mastoid behind. In this space

the common carotid artery lies superficial, and at the upper border of the thyroid cartilage divides into its terminal branches, the external and internal carotids.

The digastric triangle is limited above by the lower border of the jaw, the parotid gland, and mastoid process of the temporal bone; behind by the posterior belly of the digastric and stylo-hyoid muscles, and in front by the anterior belly of the digastric muscle. The external and internal carotid arteries, with the internal jugular vein and pneumogastric nerve, pass through this space.

The posterior triangle is subdivided into two smaller triangles, by the posterior belly of the omo-hyoid muscle, the occipital and the subclavian.

The occipital triangle is bounded, in front, by the posterior border of the sterno-mastoid; behind, by the anterior border of the trapezius; and, below, by the posterior belly of the omo-hyoid.

The subclavian, the smaller and more important of the posterior subdivisions, is formed by the posterior border of the sterno-mastoid in front, the upper border of the clavicle below, and the posterior belly of the omo-hyoid above. In this space is found the subclavian artery as it arches across the root of the neck.

The Common Carotid Artery.—SURGICAL ANATOMY.—For the purposes of ligation, the common carotid artery may be divided into two parts, that above the anterior belly of the omo-hyoid muscle extending to the point of bifurcation opposite the upper border of the thyroid cartilage, and that below the muscle terminating at the sterno-clavicular articulation (Fig. 255). The upper portion lies in the superior carotid triangle (Fig. 254, *b*). Owing to the

lingual, and superior thyroid

Fig.

The Common Carotid Artery.

internal jugular. Below the o
occupies the inferior carotid tr
it is deeply placed, lying beneat
thyroid, and sterno-hyoid musc

structures which converge to the root of the neck. On the right side the internal jugular vein separates from the artery, while on the left it approaches, and usually crosses, its lower part, in order to unite with the subclavian vein.

It is also to be remembered that the carotid arteries present, frequently, peculiarities relating to origin, point of bifurcation, and branches. In a surgical point of view, the most important peculiarity is that which relates to the point of division in the neck. In the order of infrequency, the points of division are given as the root of the neck, opposite the middle of the larynx or lower border of the cricoid cartilage, opposite the hyoid bone or beyond this point.

The artery occasionally gives origin to the superior thyroid or a laryngeal branch, the inferior thyroid or, very rarely, the vertebral artery.

After ligature of the common carotid artery, the collateral circulation is freely established both within and without the cranium by the branches of both carotid arteries and those of the subclavian artery on the side on which the ligature has been applied. Outside, the superior and inferior thyroid and the profunda cervicis of the superior intercostal and arteria princeps cervicis of the occipital, form the principal channels of communication, while, within the cranium, the vertebral artery takes the place of the internal carotid.

Course.—From the sterno-clavicular articulation upward and backward to a point midway between the mastoid process of the temporal bone and the angle of the lower jaw.

Surface marking.—The sterno-cleido-mastoid muscle.

General relations.—Above the Omo-hyoid Muscle.—In front.—Skin, superficial fascia, platysma and deep fascia,

sterno-mastoid, sterno-hyoid an
jugular and middle thyroid vein

Behind.—Longus colli and r
sympathetic nerve, inferior th
laryngeal nerve.

Inside.—Pharynx, larynx, in
rent laryngeal nerve, thyroid gl

Outside.—Internal jugular ve

Guide.—The sterno-cleido-m

Structures to be avoided.—I
veins, sterno-mastoid artery, d
mogastric nerve. In the lo
thyroid artery, recurrent la
nerves.

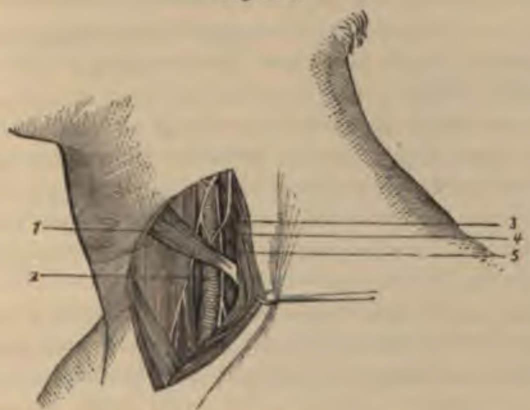
Common sheath.—Including
internal jugular vein on the o
tric nerve behind and to the out

OPERATION.—Above the om
angle of election.

The head being thrown bac
opposite side, an incision, from
inches in length, is made, beg
cornu of the hyoid bone and r

posed. Lying beneath this, separated by a layer of the deep fascia, is found the common sheath of the vessels, with the descendens noni nerve upon its anterior surface. Pushing this gently aside, the common sheath is now to be opened to a very slight extent, the artery separated gently from the vein and nerve, and the ligature passed in a direction from the vein, being careful to avoid the nerve (Fig. 256).

Fig. 256.



1. Anterior belly of the omo-hyoid muscle.
2. Common carotid artery, with descendens noni nerve on its anterior surface.
3. Internal jugular vein.
4. Pneumogastric nerve.
5. Sterno-mastoid muscle drawn aside.

Operation.—Below the omo-hyoid muscle in the *triangle of necessity.*

An incision from two and a half to three inches in length should be made from opposite the cricoid cartilage to a point one-quarter of an inch above the sternum along

outer side, and the sterno-h
to the inner side. The she
the layers of the deep fasc
opened carefully, and the lig
being taken to avoid the pn
noni nerve, which latter he
side (Fig. 256).

In performing the operatio
the surgeon should bear in
anterior belly of this muscle
insertion on the hyoid bone, a
the artery. From its point o
the scapula, it passes forward
leaving the line of the upper l
until it reaches the sterno-m
becomes tendinous and cha
almost vertically upward to
obtuse angle. This direction
point slightly below the mid
applied just above its upper
artery should be ascertained,
expose this part. This point

superior thyroid veins. Attention is also directed to the intimate relation which the internal jugular vein has to the artery; the large column of blood it carries brings it prominently into the wound, and the extreme thinness of its walls renders it liable to be easily wounded.

In the operation below the omo-hyoid muscle, the relations of the middle thyroid vein, the inferior thyroid artery, and the recurrent laryngeal nerve, with the position of the internal jugular vein across the artery at the root of the neck on the left side, should be borne in mind.

The importance of the sterno-mastoid muscle as a guide to the carotid artery, should not be forgotten. In its entire extent it may be said to be covered and protected by this muscle, being placed well under it in the first part of its course, and gradually approaching its anterior border as it ascends the neck. The muscle is embraced between two layers of the deep cervical fascia, which unite at its anterior border. When the fibres of the muscle are exposed in the operation, it is to be remembered that but one layer of the envelope of the muscle has been divided, and that another lies beneath, separating the muscle from the sheath of the vessels, which must be divided before the sheath is reached.

The External Carotid Artery.—SURGICAL ANATOMY.—Owing to the complicated relations of this vessel, and the number of branches given off from it, ligation, except in cases of wounds, is rarely performed. If necessary, a ligature may be applied near its origin or above the posterior belly of the digastric muscle. In the first part of its course, the artery lies in the triangular space formed by the sterno-mastoid behind, the anterior belly of the omo-hyoid below, and the posterior belly of the digastric above. In this space

Course.—From the upper bo
upward, forward, and backwar
neck of the condyle of the lowe
tory meatus.

Surface markings.—Sterno-m
border of the ramus of the lowe

General relations.—*In fron*
platysma muscle, deep fascia, h
lingual veins, digastric and styl

Behind.—Superior laryngeal a
stylo-glossus and stylo-pharynge

Internally.—Hyoid bone and
jaw.

Guides.—Below, sterno-masto
belly of the digastric muscle and

Structures to be avoided.—Li
hypoglossal nerve.

OPERATION.—At the point o
ligature may be applied by the
that adopted in the ligature of
above the omo-hyoid muscle (
made from a point opposite the
bone downward to the

avoid the internal carotid artery which lies behind and somewhat external.

Above the posterior belly of the digastric muscle, the artery is reached by an incision extending from the lobe of the ear to the great cornu of the hyoid bone, dividing the skin. The superficial fascia, platysma, and deep fascia are divided carefully on the director, exposing the parotid gland. The posterior belly of the digastric, with the stylo-hyoid muscle, are found below at the bottom of the wound, and are to be separated from the parotid gland above, when the artery will be exposed before its entrance into the substance of the gland.

In applying a ligature to the artery at this point, the surgeon should recall the position of the numerous venous trunks which occupy this region. Some of these are necessarily divided, and give rise to considerable hemorrhage, which complicates the operation. When necessary, these should be tied with two ligatures, and then divided. If cut before being tied, and the amount of hemorrhage warrants it, a ligature should be applied as in the arteries. In this region, also, there will be found most important structures, vessels, and nerves, which are to be dealt with cautiously.

The Superior Thyroid Artery.—SURGICAL ANATOMY.—This vessel is the first branch of the external carotid artery, being given off just above the point of bifurcation (Fig. 255). It lies superficially in the triangle of election at the beginning of its course, and can be reached readily.

Course.—From the point of origin below the greater cornu of the hyoid bone upward and inward, then curving downward and forward to the upper part of the thyroid gland.

Fig. 257.

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view,

The Lingual Artery.—
artery is the second branch of
from its anterior surface (Fig.

Course.—From the external
greater cornu of the hyoid
inward, horizontally forward
and then vertically upward
tongue.

Surface marking.—Hyoid bo

Second portion.—In front.—Superficial structures, with the digastric and stylo-hyoid muscles and hypoglossal nerve.

Behind.—Middle constrictor muscle.

Below.—Greater cornu of the hyoid bone.

Above.—Muscles of the tongue.

Guides.—Posterior belly of the digastric muscle and the hypoglossal nerve.

Structure to be avoided.—Hypoglossal nerve.

OPERATION.—A transverse incision is made along the upper border of the hyoid bone from a point in the median line of the neck a little below the symphysis of the lower jaw to near the border of the sterno-mastoid muscle, dividing the skin. The superficial fascia, platysma, and deep fascia should be divided on the director. Seek for the posterior belly of the digastric muscle and hypoglossal nerve. The artery will be found along the upper border of the great cornu of the hyoid bone just as it passes beneath the hypoglossus muscle. If not found at this point, it may be necessary to divide the attachment of the hypoglossus muscle in order to reach the vessel and apply the ligature. Care should be taken to avoid the hypoglossal nerve (Fig. 257).

The Facial Artery.—SURGICAL ANATOMY.—This is the third branch given off from the anterior surface of the external carotid artery, and may be ligatured as it passes over the border of the lower jaw, at the anterior inferior angle of the masseter muscle (Fig. 255, 9).

Course.—From the point of origin a short distance above the cornu of the hyoid bone, obliquely forward and upward to the submaxillary gland, passing through a groove on its upper surface and upward over the body of the lower jaw at the anterior inferior angle of the masseter muscle; forward

and upward to the angle of the mouth, upward along the side of the nose, terminating at the inner canthus of the eye.

Surface marking.—Masseter muscle.

Relations at the point of ligature.—In front.—Skin and superficial fascia.

Behind.—Body of the lower jaw.

Externally.—The masseter muscle and facial vein.

Internally.—The depressor anguli oris muscle.

Guide.—The anterior inferior angle of the masseter muscle.

Structure to be avoided.—The facial vein.

OPERATION.—Fix the position of the anterior inferior angle of the masseter muscle, and make an incision, one inch in length, in the line of the artery, dividing the skin. The superficial fascia and fibres of the platysma muscle being divided on the director, the artery will be exposed with the vein to the outside. The ligature is to be passed, avoiding the vein (Fig. 257).

The Temporal Artery.—SURGICAL ANATOMY.—This artery is the smaller of the two terminal branches of the the external carotid, and takes its origin in the substance of the parotid gland at a point midway between the neck of the condyle of the lower jaw and the external auditory meatus. Two inches above the root of the zygoma, over which it passes, it divides into the anterior and posterior temporal branches.

Course.—From the interspace between the neck of the condyle of the lower jaw and the external meatus, directly upwards over the root of the zygoma.

Surface marking.—Root of the zygoma.

General relations.—In front.—Skin, superficial fascia,

attrahens aurem muscle, and dense fascia from over the parotid gland; superficial veins and nerves.

Behind.—Zygomatic arch.

Outside.—External auditory meatus.

Inside.—Origin of masseter muscle.

Guide.—Zygomatic arch.

Structures to be avoided.—Temporal vein and branches of auriculo-temporal nerve.

OPERATION.—An incision one inch in length and one-third of an inch in front of the tragus should be made in the line of the vessel, dividing the skin. The superficial fascia, attrahens aurem muscle, and parotid fascia are to be divided carefully on the director, and the artery will be found lying on the zygoma. The vein which lies to the outside should be avoided in passing the ligature (Fig. 257).

The Occipital Artery.—SURGICAL ANATOMY.—The occipital artery is the first branch of the external carotid arising from the posterior part.

Course.—From the point of origin near the lower margin of the digastric muscle obliquely upward across the internal carotid to a point between the transvere process of the atlas and the mastoid process of the temporal bone, then horizontally backward in a groove on the surface of the bone, and vertically upward to the occiput.

Surface marking.—Mastoid process of temporal bone.

Relations at point of ligation.—*In front.*—Skin, aponeurosis of the sterno-mastoid muscle, splenius, digastric, and trachelo-mastoid muscles.

Behind.—Complexus, superior oblique, and rectus posticus major muscles.

Guide.—Mastoid process.

Structure to be avoided.—Occipital vein.

OPERATION.—The artery can be reached by making an incision one inch and a half in length over its course from the mastoid process of the temporal bone to the external occipital protuberance, dividing the skin. The fascia, aponeurosis of the sterno-mastoid muscle, and the splenius capitis muscle must be divided, when the artery will be exposed, and the ligature applied, avoiding the vein which lies to the outside (Fig. 257).

The Internal Carotid Artery.—SURGICAL ANATOMY.—The beginning of the first portion of this vessel is quite superficial, contained, as it is, in the superior carotid triangle, and being on the same plane with, but behind, the external carotid (Fig. 255, 10). As it ascends it approaches the vertebræ lying above on the pre-vertebral structures. Ligature just above the point of bifurcation may therefore be performed. Above the point where it is crossed by the stylo-hyoid and posterior belly of the digastric muscles, its relations are so complicated that any operation performed with a a view to apply a ligature will be attended by serious difficulties.

Course.—From the point of bifurcation of the common carotid artery opposite the upper border of the thyroid cartilage, vertically upward to the carotid foramen in the petrous portion of the temporal bone.

Surface marking.—Sterno-mastoid muscle.

General relations.—*In front.*—Skin, superficial fascia, platysma, deep fascia, sterno-mastoid, digastric, and stylohyoid muscles; external carotid and occipital arteries; hypoglossal nerve, and parotid gland.

Behind.—Rectus anticus major muscle, and superior laryngeal nerve.

Outside.—Internal jugular vein and pneumogastric nerve.

Inside.—Pharynx, tonsil, and ascending pharyngeal artery.

Guide.—Inner edge of sterno-mastoid muscle.

Structures to be avoided.—Internal jugular vein, external carotid artery, and pneumogastric nerve.

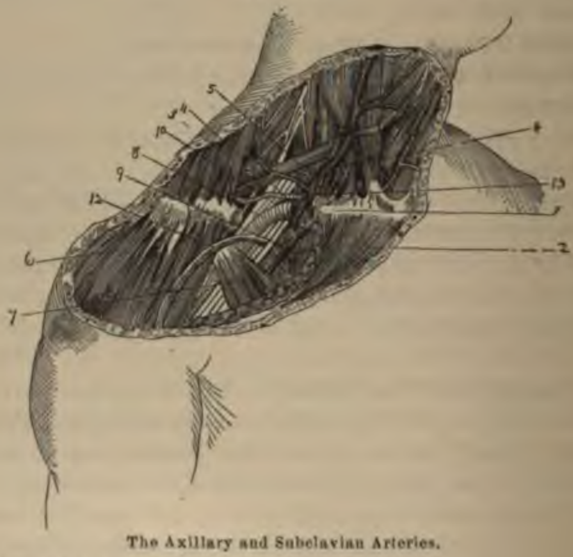
OPERATION.—The operation for applying the ligature to the artery just above the point of bifurcation is the same as that performed in ligaturing the external carotid at this point. The incision should be made along the anterior edge of the sterno-mastoid muscle, somewhat to the outside of that made in securing the external carotid, owing to the position of the internal behind the external carotid.

The Subclavian Artery.—SURGICAL ANATOMY.—This vessel, on the right side, arises from the innominate artery behind the sterno-clavicular junction, and ascends obliquely outward to the inner border of the scalenus anticus muscle; outward, behind the muscle, and from the outer border obliquely outward and downward beneath the cleviele to the lower border of the first rib, terminating in the axillary artery (Figs. 258, 259). On the left side it takes origin from the transverse portion of the arch of the aorta, and ascends almost vertically to the inner border of the scalenus anticus muscle, taking then the same course as on the right side. The scalenus anticus muscle therefore divides it into three parts; the first lying to the inner side, the second behind, and the third extending from the outer side to the lower border of the first rib.

Ligature of the first and second parts is very rarely

practised; the branches given off from the first part render the operation extremely hazardous, as well as prevent com-

Fig. 258.



The Axillary and Subclavian Arteries.

1. Clavicle cut across.
2. Pectoralis major muscle partially cut away.
3. Trapezius muscle.
4. Sterno-cleido-mastoid.
5. Omo-hyoid.
6. Deltoid.
7. Pectoralis minor.
8. The axillary artery.
9. The axillary vein.
10. The brachial plexus, above and behind.
11. Supra-scapular artery.
12. Cephalic vein passing in inter-space between deltoid and pectoralis major muscles to enter into axillary vein just above upper border of pectoralis minor muscle.
13. External jugular vein.

plete interference with the circulation by means of the ligature. If it should become necessary, it can be reached by the same incision as is made in ligaturing the innominate artery.

The second part lies deeply behind the muscle, and offers no advantage over the third part, which is readily reached.

The third part has no branches, and is placed in a triangular space formed above by the posterior belly of the omo-hyoid muscle; below by the clavicle, and to the inner side by the sterno-mastoid muscle. The size of this space is increased or diminished by the extent of attachment of the sterno-mastoid and trapezius muscles to the clavicle, the proximity of the posterior belly of the omo-hyoid to the border of the clavicle, and the position of the shoulder, whether depressed or elevated. In this space the artery has important relations with the surrounding structures. The subclavian vein lies beneath the clavicle at this point of its course; occasionally it rises into this space, and is in relation in front. The brachial plexus of nerves lies above and in close relation to the artery; the supra-scapular vessels pass transversely across the space near the margin of the clavicle; the transverse cervical nerves cross its upper angle; the external jugular vein passes down the neck along the posterior border of the sterno-mastoid, and empties into the subclavian vein; it receives superficial veins, which lie in front of the artery.

Fig. 259.

The Subclavian Artery.
1. Subclavian artery.
2. Subclavian vein.
3. First rib
4. Scalenus anticus muscle, between vein and artery.

It is important to note the height to which the artery in its course rises in the neck. Normally, it may be said to

the fascia and seek for the scalenus anticus muscle, and trace it to its insertion in the tubercle on the first rib—to its outer side the artery crosses the rib, where it can be felt. Pass the ligature carefully from below upward (Fig. 260).

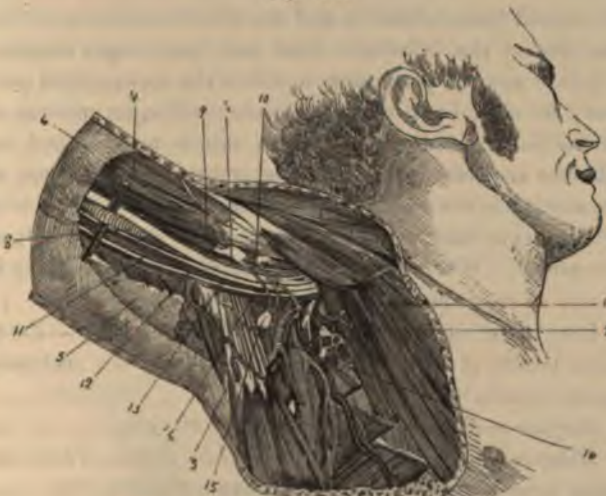
The Axillary Artery.—SURGICAL ANATOMY.—The axillary artery is a continuation of the subclavian, beginning at the lower border of the first rib, passing downward through the axillary space and terminating at the lower borders of the latissimus dorsi and teres major muscles in the brachial (Figs. 258, 261).

The axillary space or axilla, through which the artery passes, is a conical-shaped cavity placed between the side of the chest above and the inner side of the arm. Its boundaries are formed by the pectoralis major and minor in front, the subscapularis, the latissimus dorsi and the teres major behind, the four upper ribs, intercostal muscles and part of the serratus magnus muscle on the inside, and the humerus, coraco-brachialis, and biceps muscles on the outside. This space contains important structures, in close relation; the axillary vessels and brachial plexus of nerves with their branches, also branches of the intercostal nerves with lymphatic glands (ten or twelve in number), all held together by a quantity of fat and areolar tissue. A prolongation of the costo-coracoid membrane surrounds, to a greater or less extent, the vessels and nerves, forming a sheath for them.

The course of the artery through this space varies according to the position of the arm. When the arm is placed in contact with the side of the chest, the artery is gently curved, the convexity looking upward and outward. With the arm at right angles to the body, it passes in a direct line,

and the arm being extended it assumes a curve, the convexity of which looks downward. It passes from the apex

Fig. 261.



Axillary Artery below Pectoralis Minor Muscle.

1. Pectoralis major muscle drawn upward.
2. Pectoralis minor.
3. Lattisimus dorsi and teres major muscles.
4. Biceps muscle.
5. Triceps muscle.
6. Deep fascia of the arm.
7. Axillary Artery.
8. Brachial artery.
9. Coraco-brachialis muscle.
10. Musculo-cutaneous nerve.
11. Median nerve.
12. Internal cutaneous nerve.
13. Ulnar nerve.
14. Axillary vein.
15. Lymphatic gland.
16. Subscapular and inferior thoracic vessels.

to the base of the axilla nearer the anterior than the posterior wall, and is divided into three parts by the pectoralis minor muscle, the first portion extending from the lower border of the first rib to the upper border of the muscle, the second lying behind it, and the third terminating at the insertion of the latissimus dorsi and teres major muscles. Ligature can be performed in either the first or third portion; the second portion is quite inaccessible, on account of its position behind the pectoralis minor muscle, and its relations are complicated by being embraced by the roots of the median nerve which arise from the inner and outer cord of the plexus, and unite either in front or on the outside of the artery. When selection is permitted, the third part is chosen as easier of access and freer from complications.

LIGATURE IN THE FIRST PORTION.—*Course.*—From lower border of first rib to upper border of the pectoralis minor muscle.

Surface marking.—Lower border of clavicle.

Relations at point of ligature.—In front.—Pectoralis major muscle, costo-coracoid membrane, cephalic vein.

Behind.—First intercostal space and muscle, second serration of serratus magnus muscle, posterior thoracic nerve.

Inside.—Axillary vein.

Outside.—Brachial plexus of nerves.

Guides.—Pectoralis major muscle, deeper, pectoralis minor muscle, and costo-coracoid membrane.

Structures to be avoided.—Superficially, cephalic vein and thoracico-acromialis artery; deeper, axillary vein and brachial plexus of nerves.

OPERATION.—The arm and the shoulder being drawn back, an incision three inches in length, one-half of an inch

below the clavicle and parallel to it, extending from the sternum to the edge of the deltoid muscle, should be made, dividing the skin. The superficial and deep fascia should be divided on the director, exposing the pectoralis major muscle. Divide the fibres of the clavicular portion of the muscle to the same extent as the external incision, and carefully incise the areolar tissue which lies below. Seek the upper border of the pectoralis minor muscle, and cautiously open the costo-coracoid membrane. Relax the pectoralis minor muscle by bringing the arm to the side, and separate, with the grooved director, the artery carefully from the vein and other structures, and pass the ligature needle from within outward, carefully avoiding the vein (Fig. 262).

Fig. 262.

1. Axillary artery.
2. Axillary vein.
3. Brachial plexus of nerves.

The artery can be reached, if necessary, in the second part by extending the incision downward.

Ligature in the Third Portion.—*Course.*—From the lower border of the pectoralis minor muscle to the lower

borders of the latissimus dorsi and teres major muscles (Fig. 261).

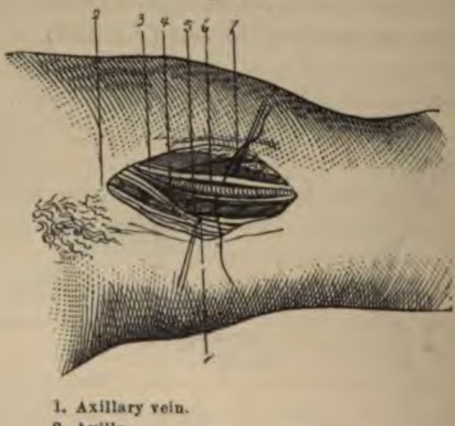
Surface markings.—Borders of the axilla, head of the humerus, inner border of the coraco-brachialis muscle.

Relations at point of ligature.—In front.—Skin, fascia, and pectoralis major muscle.

Behind.—Subscapularis, latissimus dorsi and teres major muscles, musculo-spiral and circumflex nerves.

Inside.—Axillary vein, ulnar, and internal cutaneous nerves.

Fig. 263.



1. Axillary vein.
2. Axilla
3. Median nerve.
4. Ulnar nerve—drawn aside.
5. Internal cutaneous nerve.
6. Axillary artery.
7. Inner border of coraco-brachialis muscle.

Outside.—Coracco-brachialis muscle, median and musculo-cutaneous nerves.

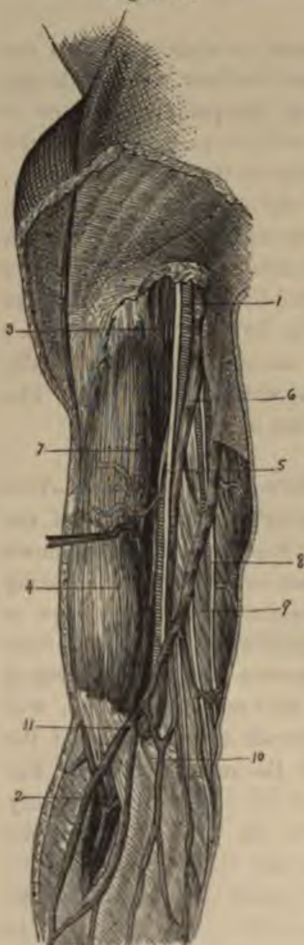
Guide.—Coraco-brachialis muscle.

Structures to be avoided.—Axillary vein, median and ulnar nerves.

OPERATION.—Placing the arm at right angles to the body, make an incision two and one half inches in length over the course of the artery, at the point of junction of the anterior and middle thirds of the axilla, dividing the skin. Divide the fascia carefully on the grooved director, separate the areolar tissue with the finger or handle of the knife, and seek the axillary vein to the inside and median nerve to the outside. Flex the arm so as to relax the vein and nerve, isolate the artery carefully, and pass the ligature needle from within outward (Fig. 263). Note a muscular slip from the latissimus dorsi muscle which occasionally crosses the artery at this point, which may mislead. The transverse direction of its fibres can be recognized.

The Brachial Artery.—SURGICAL ANATOMY.—This artery begins at the lower border of the tendons of the latissimus dorsi and teres major muscles, and passes down on the inner and anterior surface of the arm, terminating about one-half of an inch below the bend of the elbow in the radial and ulnar arteries (Fig. 264). A line drawn from the point of junction of the anterior and middle thirds of the axilla to a point midway between the condyles, will indicate its course. As it descends it winds around the bone, passing from the inner to the anterior surface. For the purposes of ligature, it may be divided conveniently into two parts, that lying above the point at which the median nerve crosses it, which may be designated as the middle of the vessel, and that below this point. In the upper part, the nerve lies to the outer side of the artery in close contact; as it descends it passes very obliquely in

Fig. 264.



The Brachial Artery.

1, 2. The brachial artery.
3. Coraco-brachialis muscle.
4. Biceps muscle.
5. Median nerve, crossing the artery.
6, 7. Venæ comites.
8. Inferior profunda artery.
9. Ulnar nerve.
10. Bicipital fascia, beneath which the artery passes.
11. Median basilic vein separated from the ar.ery by bicipital fascia.

front, and occasionally behind, and takes a position to the inner side. The artery also presents a number of peculiarities as to course, point of bifurcation, and muscular relations which should be considered by the surgeon.

Its course down the arm may be varied by a departure from the inner border of the biceps muscle to the inner condyle of the humerus, and then to the bend of the elbow, passing through the pronator radii teres muscle. Irregularity with regard to the point of bifurcation is of rather frequent occurrence; it occurs more frequently in the upper than in the middle or lower part of the arm—

in three out of four cases it takes place as a high division of the radial, which arises from the inner surface of the brachial, and passes down the arm parallel with the main trunk to the elbow, where it crosses the artery to the outside. In these cases, two large vessels would be found, which should be carefully examined, in order to decide to which one the ligature should be applied.

Occasionally it is found that muscular layers passing between the coraco-brachialis and triceps muscles, and between the other muscles, have covered the artery for some distance in its course; these must be divided, in order to reach the vessel.

Course.—From the lower margin of the teres major muscle to one-half of an inch below the bend of the elbow. A line drawn from the point of junction of the anterior and middle thirds of the axilla to a point midway between the condyles, will indicate its course.

Surface markings.—Inner border of the coraco-brachialis and biceps muscles.

General relations.—*In front.*—Skin and fascia, median nerve, and median basilic vein.

Behind.—Triceps, coraco-brachialis, and brachialis anticus muscles; musculo-spiral nerve, and superior profunda artery.

Inside.—Internal cutaneous, ulnar, and median nerves.

Outside.—Median nerve, coraco-brachialis and biceps muscles.

Guides.—Inner border of coraco-brachialis and biceps muscles.

Structures to be avoided.—Median nerve, possibly ulnar nerve, and superior profunda artery; internal cutaneous nerve and basilic vein.

OPERATION.—Above the point at which the median nerve crosses the artery.

The arm being drawn from the side, and the hand supinated, an incision from two to three inches in length should be made along the inner border of the coraco-brachialis muscle, dividing the skin. The superficial and deep fasciæ should be divided carefully on the director, care being taken to avoid the internal cutaneous nerve. The artery, accompanied by venæ comites, will be found lying along the border of the coraco-brachialis muscle; the internal cutaneous and ulnar nerves and basilic vein being to the inner, and the median nerve to the outer side. Separate the venæ comites, and pass the ligature-needle from within outward, avoiding the vein.

OPERATION.—Below the point at which the median nerve crosses the artery.

The arm being in the same position as in the operation just described, an incision from two three inches is made directly over the inner border of the biceps muscle, dividing the skin. The superficial and deep fasciæ are very carefully divided, in order to avoid the basilic vein, which at this point is superficial. The median nerve is now seen as a large white cord lying to the inside of the artery. Flex the arm so as to relax the biceps and median nerve, and separate the venæ comites from the artery. Pass the ligature-needle from within outward (Fig. 265).

In this operation the attention of the surgeon is directed to the position of the artery, median nerve, and ulnar nerve, and their relation to each other. The artery, at this point, lies in very close contact with the border of the biceps, the median nerve separated slightly to the inner side, and the ulnar nerve removed some distance from the median,

and passing inward and backward. If the incision is made too far from the inner border of the biceps muscle, the ulnar nerve may be mistaken for the median, and thus confusion arise. This error can be avoided by keeping near to the border of the biceps muscles and bearing in mind the order

Fig. 265.

1. Venæ comites.
2. Median nerve.
3. Brachial artery.
4. Biceps muscle.

of relation from without inward, which is as follows; inner edge of biceps—artery in close contact; median nerve slightly separated from artery; ulnar, separated to some distance from median nerve (Fig. 264).

The Brachial Artery at the Bend of the Elbow.—SURGICAL ANATOMY.—At this point the artery occupies a position beneath the tendon of the biceps in a triangular space formed by the supinator longus muscle externally, the pronator radii teres internally, the floor being formed by the brachialis anticus and supinator brevis muscles.

and bicipital fascia.

Behind.—Brachialis anticus muscle

Inside.—Median nerve.

Outside.—Supinator longus muscle.

Guide.—Inner edge of tendon of bi

Structures to be avoided.—Median

nerve.

OPERATION.—Make an incision tw in length along the inner edge of th

Fig. 266.

1. Brachial artery.
2. Median nerve.
3. Tendon of biceps muscl
4. Pronator radii teres mu

by the venæ comites, beneath and lying between the tendon of the biceps muscle on the outside and the median nerve on the inside. Pass the ligature-needle from the median nerve (Fig. 266).

The Radial Artery.—SURGICAL ANATOMY.—The radial artery, the smaller of the two vessels into which the

Fig. 267.

The Radial and Ulnar Arteries.

1. Brachial artery.
2. 2. Radial and ulnar arteries at point of bifurcation.
3. Ulnar artery, middle third.
4. Ulnar artery, lower third.
5. Superficial palmar arch.
6. Radial artery, middle third.
7. Radial artery, lower third.
8. Median nerve.
9. Median basilic vein.
10. Bicipital fascia.
11. Median nerve crossing ulnar artery.
12. Ulnar nerve.
13. Tendon and muscle of flexor carpi ulnaris.
14. Inner tendon of the flexor sublimis digitorum.
15. Supinator longus muscle.
16. Pronator radii teres muscle cut through.
17. Superficial flexor muscle cut through, showing ulnar artery and median nerve.
18. Beginning of tendon of supinator longus muscle.
19. Radial nerve.
20. Venæ comites.

course in the upper, middle, or low

Course.—A line drawn from th
the elbow to the front of the styloi
its course.

Surface marking.—Inner border
don of the supinator longus.

General relations.—*In front.*—S
fasciæ, supinator longus muscle.

Behind.—Tendon of biceps m
pronator radii teres, flexor sublimis
pollicis, pronator quadratus muscles,

Inside.—Pronator radii teres mus
muscle, and tendon.

Outside.—Supinator longus muscl

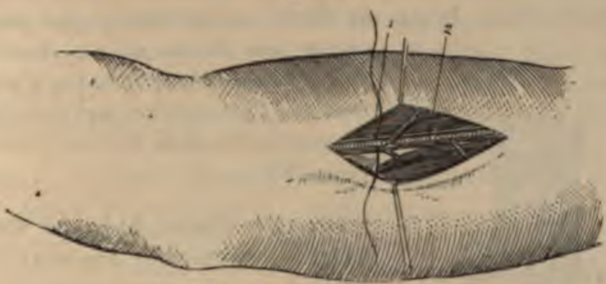
Guide.—Supinator longus muscle

Structures to be avoided.—Median

OPERATION.—*In the upper third.*
to three inches in length, dividing
avoiding the median vein, is made
elbow obliquely downward and outw
marks the line of separation betwee
and pronator radii teres muscles. T

rating the venæ comites, the ligature needle is passed from without inward (Fig. 268).

Fig. 268.



1. Supinator longus muscle.
2. Radial artery.

In the middle third.—The artery can be exposed by an incision two inches in length along the inner border of the supinator longus muscle, dividing the skin. The fasciæ being divided, the artery is found, with the radial nerve in close contact, on the outside. Pass the ligature needle from the nerve.

Fig. 269.

1. Deep fascia.
2, 4. Venæ comites.
3. Artery.

In the lower third.—At this point the artery lies superficial between the tendons of the supinator longus and flexor carpi radialis, the nerve being some distance to the

outside, leaving the artery about three inches above the wrist. Fix the position of the tendon of the flexor carpi radialis muscle by manipulating the hand, and make an incision one inch and a half along its external border, dividing the skin. Divide the fasciæ on the director, and thus expose the sheath of the vessel. Open the sheath, separate the artery from the venæ comites, and pass the ligature needle from without inward (Fig. 269).

Fig. 270.

Radial Artery on the outer side of the Wrist.

1. Posterior annular ligament of the carpus.
2. Tendon of extensor ossis metacarpi pollicis.
3. Tendon of extensor primi internodii pollicis.
4. Tendon of the extensor secundi internodii pollicis.
5. Radial artery.

On the Outer Side of the Wrist.—Surgical Anatomy.—The artery, as it crosses to the outer side of the wrist to pass into the hand, lies beneath the extensor tendons of the thumb, in a space known as the "snuff-box" (Fig. 270). Here it can be ligatured by making an incision, which divides the skin, one inch and a quarter in length, beginning opposite the styloid process of the radius and terminating at the first interosseous space. Dividing the fasciæ on the director, seek the tendon of the extensor secundi internodii pollicis muscle, which crosses the artery just before it passes into the palm of the hand, and furnishes a guide to the vessel. Apply the ligature to the artery on the ulnar side of the tendon, avoiding the veins and a small branch of the musculo-cutaneous nerve which accompanies it.

The Ulnar Artery.—SURGICAL ANATOMY.—This vessel, the larger of the two terminal branches of the brachial artery, begins at the point of bifurcation opposite the coronoid process of the ulna, and crosses obliquely to the inner side of the forearm, which it reaches about the middle, then descends along the ulnar border to the wrist, terminating in the superficial palmar arch. A line drawn from the internal condyle of the humerus to the outer side of the pisiform bone, will indicate its course in the lower half. Ligature in the upper portion is rarely performed, owing to the position of the vessel beneath the superficial flexor muscles, which must be divided in order to apply the ligature. In a preparation, in possession of the author, the arteries of both sides pass above the superficial flexor muscles, a high bifurcation occurring on the left side, the right ulnar being given off from the lower portion of the axillary. In the middle part it is slightly covered by the tendons of the flexor carpi ulnaris and the inner tendon of the flexor sublimis digitorum. In the lower part it is superficial. The median nerve crosses it obliquely just below its point of origin, while the ulnar nerve comes into close relation with it at the lower part of the upper half (Fig. 267).

Course.—From the bend of the elbow to the radial side of the pisiform bone.

Surface marking.—Muscle and tendon of the flexor carpi ulnaris.

General relations.—*In front.*—*Upper half.*—Superficial flexor muscles and median nerve.

Lower half.—Superficial and deep fasciæ.

Behind.—Brachialis anticus and flexor profundus digitorum muscles.

Inside.—Flexor carpi ulnaris muscle and, in lower two-thirds, ulnar nerve.

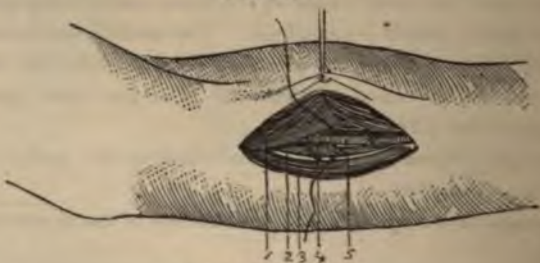
Outside.—Muscle and tendons of the flexor sublimis digitorum.

Guide.—Muscle and tendon of the flexor carpi ulnaris.

Structures to be avoided.—Ulnar nerve and venæ comites in upper half; median nerve.

OPERATION.—*In upper half.*—An incision should be made starting two and one-half inches below the internal condyle of the humerus, and one-quarter of the width of the arm from the inner edge, extending downward to the extent of three inches, dividing the skin. The fasciæ being divided, seek the white, pearly aponeurotic line marking the septum between the flexor carpi ulnaris muscle on the inside, and the flexor sublimis digitorum on the outside. Incise this septum to the same extent as the incision through the skin

Fig. 271.



1. Flexor sublimis muscle.
2. Ulnar nerve.
3. Flexor profundus muscle.
4. Venæ comites.
5. Ulnar artery.

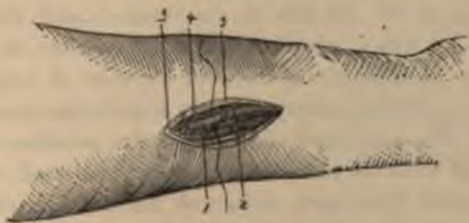
and fasciæ. Flex the arm, and separate with the finger the superficial muscles from the flexor profundus digitorum.

Seek the artery lying on this muscle with the ulnar nerve to the inside. Pass the ligature-needle from the nerve (Fig. 271).

In ligaturing the vessel at this point the surgeon should take especial care in seeking for the septum which separates the flexor carpi ulnaris from the flexor sublimis digitorum muscle, and which is to be divided in preference to the muscular substance. It will be recognized as a white, glistening membrane, the fibres of which are parallel with the fibres of the muscles.

In middle of the forearm.—The artery can be reached by an incision three inches in length along the external border of the flexor carpi ulnaris, dividing the skin. The fasciæ being divided, the flexor carpi ulnaris and the inner tendon

Fig. 272.



1. Flexor carpi ulnaris muscle.
2. Venæ comites.
3. The integuments.
4. Ulnar artery.
5. Deep fascia.

of the flexor sublimis digitorum should be separated, exposing the artery with the ulnar nerve to the inside in close relation. Pass the ligature-needle from the nerve, avoiding the venæ comites.

In lower half.—An incision two inches in length is made along the outer edge of the tendon of the flexor carpi ulnaris muscle *three-quarters of an inch from the ulnar border* of the limb, dividing the skin. Divide the fasciæ on the director, and, slightly flexing the hand, seek the artery covered by the tendon of the flexor carpi ulnaris and inner tendon of the flexor sublimis digitorum muscle. Separate the venæ comites, and pass the ligature from within outward (Fig. 272).

In this operation the surgeon is cautioned against making the incision too near the ulnar border of the limb.

The Abdominal Aorta.—Surgical Anatomy.—The abdominal portion of the aorta is the continuation of the thoracic portion, beginning at the opening in the diaphragm opposite the body of the last dorsal vertebra, descending on the left side of the vertebræ, and terminating on the left side of the fourth lumbar vertebra in the two common iliac arteries. Between the point of origin of the inferior mesenteric artery, a large branch, and the bifurcation of the aorta into the common iliac arteries, there are given off from the posterior surface several small branches, four lumbar from each side, and the sacra media. This portion of the vessel, therefore, presents itself as best adapted for the application of the ligature, as well for this reason as on account of its position rendering it easier of access.

Course.—From the front of the body of the last dorsal vertebra downward on the left side of the vertebral column to the left side of the body of the fourth lumbar vertebra at the point of bifurcation.

Surface marking.—The linea alba.

Relations at point of ligature.—In front.—The structures forming the abdominal wall, transverse colon, omentum, and mesentery; convolutions of the small intestines, peritoneum.

Behind.—Left lumbar veins and vertebræ.

Right side.—Inferior vena cava.

Left side.—Sympathetic nerve.

Guide.—Vertebral column.

Structures to be avoided.—Inferior vena cava, sympathetic nerve.

Operation.—The vessel can be reached by two methods of operation.

1. By an incision three inches in length through the skin, beginning one and a half inch above umbilicus in the linea alba. Carrying the incision around umbilicus, divide the structures on the director until the peritoneum is reached; incise this on the director, thus opening the abdominal cavity. Raise the omentum, and push the intestines to the right side. Seek the aorta on the left side of the lumbar vertebræ, and carefully tear through the peritoneum covering the vessel. Pass the ligature from the right to the left, avoiding the vena cava.

2. An incision should be made on the left side of the body from the end of the eleventh rib to the crest of the ilium, dividing the common integuments. The layers of muscles, external and internal, oblique and transversalis, and transversalis fascia, should be carefully divided on the director. Cautiously push off the posterior layer of the peritoneum until the aorta is uncovered, and pass the ligature as in the first method.

The advantage this method has over the first, is in preserving the integrity of the peritoneum. On the other

hand, the operation by the second plan involves the wounding of the muscular structures, and separation, to some extent, of the peritoneum from the underlying structures.

The Common Iliac Artery.—SURGICAL ANATOMY.—The common iliac arteries, terminal branches of the aorta, begin at the point of bifurcation on the left side of the body of the fourth lumbar vertebra, and pass downward and outward to the margin of the pelvis. Opposite the intervertebral substance, between the last lumbar vertebra and the sacrum, they divide into the external and internal iliac arteries. The point of bifurcation of the aorta cor-

Fig. 273.

The Common, External, and Internal Iliac Arteries.

1. Section of the muscles of the abdomen at their insertion into crest of the ilium.
2. Superior spinous process of the ilium.
3. Fascia lata of the thigh.
4. Psoas muscle.
5. Iliacus internus muscle.
6. Aorta.
7. Right common iliac artery.
8. External iliac artery.
9. Internal iliac artery.
10. Iliac vein.
11. Inferior vena cava.
12. Anterior crural nerve.
13. Lymphatic glands.
14. Spermatic vessels.
15. Circumflex iliac artery.
16. The ureter.
17. The epigastric artery.

responds to a point to the left of the umbilicus, and on a level with a line passing between the highest points on the crests of the ilia (Fig. 273).

It is to be noted that these vessels lie beneath the peritoneum, and that the relation of the vein on the right and left side differs, being behind and *external* on the right side, and behind and *internal* on the left. High up, the left vein passes behind the right common iliac artery to join the right vein in forming the inferior vena cava. Peculiarities with regard to point of origin, point of division, and relative length are frequently observed, and should be borne in mind.

Course.—From bifurcation of aorta on left side of body of fourth lumbar vertebra, downward and outward to opposite the intervertebral substance between last lumbar vertebra and sacrum. A line drawn from the left side of the umbilicus to the middle of Poupart's ligament indicates the course. Length of the vessel, two inches.

Relations at point of ligation.—Right common iliac artery.—In front.—Peritoneum, ileum, branches of sympathetic nerve; at the point of bifurcation into the external and internal iliac arteries, it is crossed by the ureter.

Behind.—The two common iliac veins.

Outside.—Inferior vena cava, right common iliac vein; psoas magnus muscle.

Left common iliac artery.—In front.—Peritoneum, branches of sympathetic nerve, rectum, superior hemorrhoidal artery; at bifurcation, crossed by left ureter.

Behind.—Left common iliac vein.

Inside.—Left common iliac vein.

Outside.—Psoas magnus muscle.

Guide.—Sacro-iliac articulation.

Structures to be avoided.—Common iliac veins, ureters, sympathetic nerve, inferior vena cava, peritoneum.

OPERATION.—An incision, in a direction outward to the anterior superior spine of the ilium, from six to eight inches in length, should be made two inches above and parallel to Poupart's ligament, beginning at the junction of the inner and middle third of the space between the symphysis pubis and the anterior superior spine of the ilium, dividing the skin. The superficial and deep fasciæ, tendon of the external oblique muscle, the internal oblique and transversalis muscles are to be carefully divided on the director, layer after layer, until the transversalis fascia is exposed. The edges of the wound should be separated by retractors, the transversalis fascia gently raised and scratched through, making an opening, into which the point of the director can be introduced. Making sure, by careful examination, that the director is *between* the fascia and the peritoneum, and not *beneath* the latter, the fascia should be divided. The peritoneum is now gently pushed off to a sufficient extent to enable the artery to be brought into view at the sacro-iliac junction. Opening carefully, with the finger nail, or with the point of the director, the sheath of the vessel, and separating the vein from the artery, the ligature is to be passed from the former.

The External Iliac Artery.—SURGICAL ANATOMY.—The external iliac artery is the larger of the two terminal branches of the common iliac, and passes from the point of bifurcation obliquely downward and outward along the inner border of the psoas magnus muscle to the crural arch. A line drawn from a point to the left of the umbilicus, to a point midway between the anterior posterior spinous

process and the symphysis pubis, will indicate its course (Fig. 273).

Course.—Obliquely downward and outward across the pelvic cavity to the crural arch.

Relations at the point of ligature.—In front.—Peritoneum, intestines, iliac fascia, spermatic vessels, genito-crural nerve, circumflex iliac vein, lymphatic vessels and glands.

Behind. — External iliac vein.

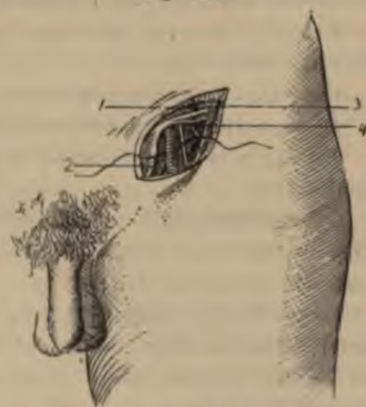
Inside. — External iliac vein and the vas deferens.

Outside.—Psoas magnus muscle, iliac fascia.

Guide.—Inner border of the psoas magnus muscle.

Structures to be avoided.—External iliac vein, genito-crural nerve, peritoneum.

Fig. 274.



1. The internal oblique and transversalis muscles.
2. The external iliac artery.
3. The external oblique muscle.
4. The peritoneum.

Operation. — This artery can be exposed by the same plan of operation as that employed in ligature of the common iliac artery (page 540). The incision need be but four inches in length, and not so far removed from the line of Poupart's ligament (Fig. 274).

The Internal Iliac Artery.—Surgical Anatomy.—The internal iliac artery, the smaller of the terminal branches

noted.

Course.—From the point of bifu
iliac, downward to the upper mar
sciatic foramen.

General relations.—*In front.*—Pe

Behind.—Internal iliac vein, lun
formis muscle.

Outside.—Psoas magnus muscle.

Guide.—Inner border of the psoas

Structures to be avoided.—Intern
peritoneum.

OPERATION.—This vessel can be
ture by the same method as that d
external iliac artery (Fig. 274).

In performing operations for the
arteries, careful attention should be
of the large venous trunks which ac
vessels lie in close contact with the
delicate and thin, and they recei
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should be exercised in using instrum
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The Gluteal Artery.—SURGICAL ANATOMY.—The gluteal artery, the largest branch of the internal iliac, is given off from the posterior trunk, and passes out of the pelvic cavity through the great sacro-sciatic foramen above the upper border of the pyriformis muscle.

Course.—A line drawn from the posterior superior spine of the ilium to the top of the great trochanter, indicates the course of the artery after its emergence from the pelvic cavity.

General relations.—*Outside.*—Skin, superficial and deep fasciæ, gluteus maximus muscle.

Inside.—Gluteus minimus muscle.

Above.—Gluteus medius muscle.

Below.—Pyriformis muscle.

Guides.—Pyriformis and gluteus medius muscles.

Structures to be avoided.—Gluteal vein and superior gluteal nerve.

OPERATION.—The patient being placed on his abdomen, an incision, five inches in length, is made over the course of the artery, dividing the skin. The superficial and deep fasciæ are divided on the director, exposing the gluteus maximus muscle. The fibres of this muscle should be separated, and the artery sought for as it emerges from the pelvic cavity above the upper border of the pyriformis muscle, and the ligature applied, carefully avoiding the veins and nerves.

The Sciatic Artery.—SURGICAL ANATOMY.—The sciatic artery is the larger of the two terminal branches of the anterior trunk of the internal iliac, and escapes from the pelvic cavity through the lower part of the great sacro-sciatic foramen.

Course.—After emerging from the pelvic cavity through the lower part of the great sacro-sciatic foramen between the pyriformis and coccygeus muscles, it passes downward in the interval between the trochanter major and tuberosity of the ischium. The point of exit from the pelvic cavity is indicated by the centre of a line drawn from the posterior superior spinous process of the ilium to the tuberosity of the ischium.

Relations.—Outside.—Skin, superficial and deep fasciæ, and gluteus maximus muscle.

Inside.—Gemellus superior and obturator internus muscles.

Above.—Pyriformis muscle.

Below.—Coccygeus muscle.

Guide.—Coccygeus muscle and lower border of the pyriformis muscle.

Structures to be avoided.—Internal pudic artery, sciatic nerve and vein.

OPERATION.—The patient being placed upon the abdomen, an incision three inches in length is made over the point of exit of the artery from the pelvic cavity, in the line given to indicate this point, dividing the skin. The superficial and deep fasciæ should be divided, exposing the fibres of the gluteus maximus muscle. Separate the fibres of this muscle, and seek the artery as it appears between the coccygeus and pyriformis muscles. Pass the ligature, carefully avoiding the nerve and vein.

The Internal Pudic Artery.—SURGICAL ANATOMY.—This artery is the smaller of the two terminal branches of the anterior trunk of the internal iliac. As it escapes from the pelvic cavity by the same opening as the

sciatic artery, its course and relations at the point of ligature are essentially the same, and it may be secured by a similar plan of operation.

The Femoral Artery. — SURGICAL ANATOMY. — The femoral artery is the continuation of the external iliac, and passes downward on the anterior and inner aspect of the thigh from the crural arch to the junction of the middle with the lower third of the thigh, where it enters an opening in the adductor magnus muscle

Fig. 275.

The Femoral Artery.

1. Poupart's ligament.
2. Aponeurosis forming Hunter's canal.
3. Anterior crural nerve.
4. Femoral artery.
5. Femoral vein.
6. Long saphenous nerve.
7, 7. Sartorius muscle, drawn to the outside.
8. Internal saphenous vein.
9. Profunda femoris artery.
10. Branch of anterior crural nerve, lying in front of the femoral sheath.
11. Another branch which passes across the vessels to join the internal saphenous vein.
12, 12. Musculo-cutaneous branches.

and becomes the popliteal (Fig. 276). The upper third of the vessel is superficial, and occupies a triangular space called "Scarpa's triangle." This triangle corresponds to the depression immediately below the fold of the groin, and is bounded by the sartorius muscle on the outside, the adductor longus muscle on the inside, and Poupart's ligament above. The floor is formed by the iliacus, psoas, pectineus, adductor longus, and a part of the adductor brevis muscles, passing in order from without inward.

The femoral vessels bisect this triangle as they pass from the middle of the base to the apex. Above, the artery lies on the inner border of the psoas magnus muscle, which

[illegible]

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Hunter's canal, and pas

ing to the inside of the thigh. The nerve acts as a guide to the vessel as it passes into this canal.

Hunter's canal, from one to two inches in length, is described as being formed by a dense fibrous aponeurosis, extending from the tendons of the adductors longus and magnus downward and inward to unite with the tendinous origin of the vastus internus muscle. It is triangular in shape, and bounded externally by the vastus internus, and internally by the adductor longus and adductor magnus muscles.

As the internal saphenous vein passes up the thigh to join the femoral, through the saphenous opening, it has an important relation to the points at which the incisions are made for exposing the artery in its lower and middle thirds, lying almost directly in the line of the incisions. The position of the vein should always be ascertained by making pressure over its course above, and it should be drawn to the inside while the incision is being made. In its course it receives numerous branches, which join it from the outer and inner surfaces of the thigh.

As ligation of the artery above the origin of the profunda femoris is not advised, it is important to determine the point at which this vessel is given off. Its normal point of origin is stated to be from one to two inches below Poupart's ligament, and from the outer and back part of the artery. Anomalies, with regard to its point of origin, are noted as occasionally occurring, the vessel being given off at or just below Poupart's ligament, and, in one instance, four inches below. In a case in which the author applied a ligature to the femoral artery for a punctured wound of the lower third, the profunda artery was found to take origin from the external iliac just above Poupart's ligament. It should also be remembered that occasionally the artery divides into

two trunks below the origin of the profunda, and reunite before entering Hunter's canal.

A rare anomaly with regard to the position of the femoral artery is noted, in which the vessel occurred as a branch of the internal iliac artery passed out of the pelvic cavity through the great sacro-sciatic foramen, and descended the thigh in its posterior aspect in connection with the great sciatic nerve. In the living subject, absence of pulsation at the crural arch would suggest the existence of such an anomaly.

Course.—From a point midway between the anterior superior spinous process of the ilium and the symphysis pubis, down the front and inner side of the thigh, terminating at the opening in the adductor magnus muscle, this opening being at the junction of the middle with the lower third of the thigh. A line drawn from the point midway between the anterior superior spinous process of the ilium and the symphysis pubis to the inner side of the inner condyle of the femur, will indicate its course.

Surface marking.—Inner edge of the sartorius musle.

General relations.—*In front.*—Skin, superficial and deep fasciæ, and sartorius muscle.

Behind.—Psoas, pectineus, adductor longus and tendon of adductor magnus muscles, femoral vein.

Inside.—Femoral vein.

Outside.—Anterior crural and internal saphenous nerves, vastus internus muscle.

Guide.—Inner border of the sartorius muscle.

Structures to be avoided.—Internal saphenous and femoral veins, internal saphenous nerve.

Common sheath.—Including artery and vein.

OPERATION.—The common femoral, above the profunda femoris.

An incision two inches in length is made over the course of the artery, beginning at a point midway between the anterior superior spinous process of the ilium and symphysis pubis, dividing the skin. The fasciæ are carefully divided on the director, and the sheath of the vessels exposed. Opening this to a slight extent, the vein is drawn inward, and the ligature needle passed from within outward (Fig. 274).

Fig. 274.

[illegible]

In the operation at this point, which is not advised, owing to the number of branches given off from the artery, care should be taken to pass the ligature above the origin of the profunda femoris, and not immediately below it. This can be accomplished by bringing into view Poupart's ligament, and applying the ligature from three-quarters of an [illegible] ligament [illegible] the ligament [illegible] Poupart's ligament [illegible]

course, the leg should be flexed upon
thigh abducted and rotated outward,
internal saphenous vein ascertained
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superficial and deep fasciæ are now div
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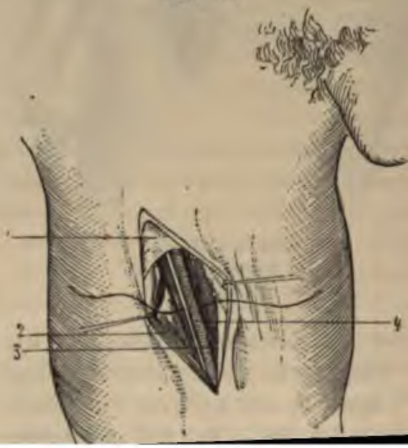
Fig. 277.



the vein should not be injured, and that it be not included in the ligature.

OPERATION.—The superficial femoral artery in Hunter's canal.

The limb being flexed and rotated outward, an incision from three to four inches in length, dividing the skin, is made in the course of the artery, over the point of junction of the middle and lower third of the thigh. The superficial and deep fasciæ are to be divided on the director, and the outer border of the sartorius muscle sought for. This muscle is drawn inward, exposing Hunter's canal, in which are placed the artery, vein, and the long saphenous nerve. The canal should be opened carefully on the director, and nicking the sheath slightly, the ligature needle should be passed from without inward, avoiding the vein and long saphenous nerve.

Attention is directed to the position of the artery, vein, and long saphenous nerve as they lie in Hunter's canal. At this point the vein is to the outside; the nerve, while it is in the canal, and before it reaches the opening in the adductor magnus, quits the outside of the artery and passes across to the inner side of the thigh. A number of branches of the nerve are distributed to the vastus internus muscle, and may be mistaken for the internal saphenous. They may be distinguished by examining carefully their relations to the artery, being placed more externally than the saphenous nerve. The vastus internus muscle can be recognized by the direction of its fibres, which pass from above downward and outward.

The Popliteal Artery.—SURGICAL ANATOMY.—The popliteal artery, the continuation of the femoral, begins at

(Fig. 278). In its
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Fig. 278.

Surgical Anatomy—Popliteal
Artery.

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1. External
2. Popliteal
3. Peroneal
4. External s
5. Branch of
6, 6. Deep fas
7. Semimembr
8. Biceps mus
9, 9. Cutaneou
10. Internal sap
11. Poplitea

the superior extremity of the tibia, and the fascia covering the popliteus muscle. The fascia lata (deep fascia) covers in the space, forming a firm protective membrane to the structures contained in it. The important bloodvessels and nerves are placed in the following order, from without inward: The internal popliteal nerve, the larger of the two terminal branches of the great sciatic is most superficial, being separated from the vessels which lie beneath by a thick layer of fat. In the upper part of the space it occupies a position to the outside of the artery, crossing it at the middle and passing to the inside as it leaves the space.

The popliteal vein, formed by the union of the venæ comites of the anterior and posterior tibial arteries, lies beneath the nerve. Occasionally the union does not take place below, and the artery is then embraced by the two veins which are in close contact with it. In the lower part of the space it is placed on the inner side of the artery, in the middle it is superficial to it, and crosses it to take a position on its outer side.

Beneath the nerve and the vein, the artery is placed in close contact with the posterior ligament of the joint. Numerous branches are given off from the artery and nerve to the joint and surrounding muscular structures, and the vein receives the external or short saphenous and branches from the joint and muscles.

The application of a ligature to the popliteal artery, owing to the relations it has to the surrounding structures, as well as the numerous branches arising from it at right angles, is necessarily, an operation in which the greatest care should be exercised. Ligature may be performed in the upper or

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Fig. 278.

Surgical Anatomy—Popliteal Artery.

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2. Poplite
3. Perone
4. Extern
5. Branch
6, 6. Deep
7. Semime
8. Biceps
9, 9. Cutan
10. Internal
11. Poplitea
12. Poplitea

the superior extremity of the tibia, and the fascia covering the popliteus muscle. The fascia lata (deep fascia) covers in the space, forming a firm protective membrane to the structures contained in it. The important bloodvessels and nerves are placed in the following order, from without inward: The internal popliteal nerve, the larger of the two terminal branches of the great sciatic is most superficial, being separated from the vessels which lie beneath by a thick layer of fat. In the upper part of the space it occupies a position to the outside of the artery, crossing it at the middle and passing to the inside as it leaves the space.

The popliteal vein, formed by the union of the venæ comites of the anterior and posterior tibial arteries, lies beneath the nerve. Occasionally the union does not take place below, and the artery is then embraced by the two veins which are in close contact with it. In the lower part of the space it is placed on the inner side of the artery, in the middle it is superficial to it, and crosses it to take a position on its outer side.

Beneath the nerve and the vein, the artery is placed in close contact with the posterior ligament of the joint. Numerous branches are given off from the artery and nerve to the joint and surrounding muscular structures, and the vein receives the external or short saphenous and branches from the joint and muscles.

The application of a ligature to the popliteal artery, owing to the relations it has to the surrounding structures, as well as the numerous branches arising from it at right angles, is, necessarily, an operation in which the greatest care should be exercised. Ligature may be performed in the upper or

lower part of its course. The middle portion should not be interfered with, owing to its deep position, its proximity to the knee-joint, and its close relations with the vein and nerve.

Course.—From the opening in the adductor magnus muscle, obliquely downward and outward to the lower border of the popliteus muscle, traversing the middle of the popliteal space.

Surface markings.—Borders of the muscles which form the boundaries of the popliteal space.

General relations.—*In front.*—Above, the inner side of the femur; in the middle, the posterior ligament of the joint; and, below, the popliteal fascia.

Behind.—The popliteal vein, layer of fat, internal popliteal nerve, fascia lata (deep fascia), superficial fascia, and skin.

Inside.—Semimembranosus and inner head of the gastrocnemius muscles.

Outside.—Biceps and outer head of the gastrocnemius muscles.

Guides.—Above, the border of the semimembranosus muscle; below, the heads of the gastrocnemius muscle.

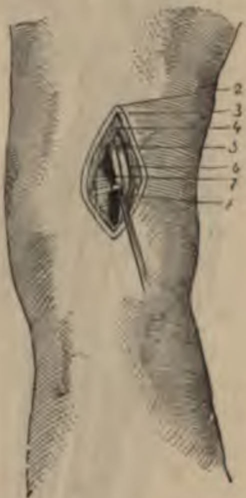
Structures to be avoided.—External saphenous vein, popliteal vein, and internal popliteal nerve, with their branches.

OPERATION.—*In upper third.*—The patient being placed in the prone position, with the limb extended, an incision three inches in length should be made along the posterior margin of the semimembranosus muscle, dividing the skin. The superficial and deep fasciæ are next divided carefully on the director, bringing into view the border of the semi-

membranosus muscle, which should be drawn inward, exposing the internal popliteal nerve lying to the outside. Separating carefully the layer of fat, which is usually found between the nerve and the vein and artery, the latter is sought for beneath the vein, and somewhat to its inner side. Detaching cautiously the artery from the vein, the ligature needle is passed from without inward (Fig. 279).

In the lower third, between the heads of the gastrocnemius muscle.—An incision, three inches in length, should be made in the middle line, or slightly to the outside of this line beginning opposite

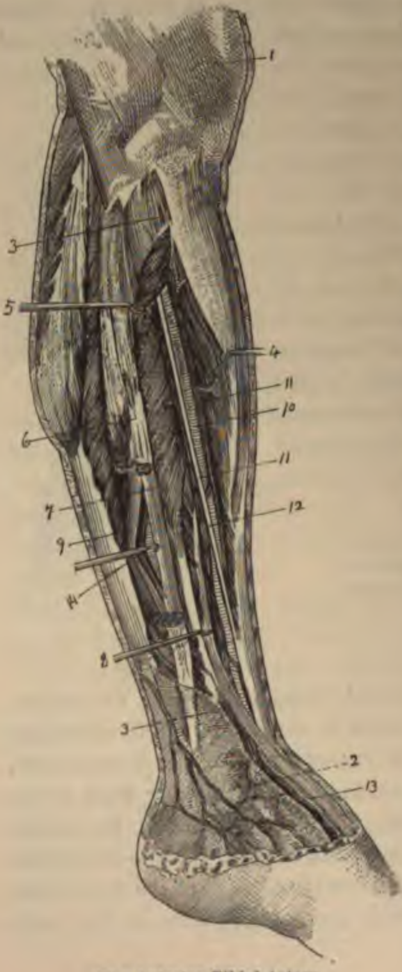
Fig. 279.



1. The popliteal artery.
2. The skin.
3. The superficial fascia.
4. The fascia lata (deep fascia).
5. The internal popliteal nerve.
6. The biceps muscle.
7. The popliteal vein.

the bend of the knee-joint, dividing the skin. The superficial and deep fasciæ should be divided on the director, care being taken to avoid the external or short saphenous vein, which perforates the deep fascia in the lower part of the popliteal space to join the venæ comites. Superficial branches of the internal popliteal nerve are also to be avoided in dividing the fasciæ. After the division of the deep fascia, the nerve, vein, and artery are found, placed in the order

Fig. 280.



The Anterior Tibial Artery.

named from without inward, between the heads of the gastrocnemus muscle. Flexing the leg, so as to relax the heads of the gastrocnemius, the nerve and vein are cautiously separated from the artery, and the ligature needle is passed from without inward.

The Anterior Tibial Artery.—SURGICAL ANATOMY.—At the lower border of the pop-

1. Patella.
2. External malleolus.
3. Deep fascia.
4. Tibialis anticus muscle.
5. Extensor longus digitorum muscle.
6. Peroneus longus and brevis muscles cut across.
7. Border of fibula.
8. Extensor proprius pollicis muscle.
9. Flexor longus pollicis.
10. Anterior tibial artery.
11, 11. Venæ comites.
12. Anterior tibial nerve.
13. Dorsalis pedis artery.
14. The peroneal artery.

liteus muscle the anterior tibial artery is given off from the popliteal, and, passing between the two heads of the tibialis posticus muscle and then between the tibia and fibula in the interspace above the upper margin of the interosseus membrane, it reaches the anterior surface of the leg, and lies upon the interosseous membrane (Fig. 280). In the upper part of its course it is connected to the interosseous membrane by delicate bands of fibrous tissue, which pass over it; and below, it lies upon the anterior surface of the tibia and the anterior ligament of the ankle-joint, passing beneath the anterior annular ligament. As it descends it changes its relations to the muscles, by reason of the direction the tibialis anticus and the extensor proprius pollicis take to their points of insertion, lying above, between the tibialis anticus and extensor longus digitorum, in the middle portion of the leg between the tibialis anticus and extensor proprius pollicis, and in the lower part between the tendon of the extensor proprius pollicis and the inner tendon of the extensor longus digitorum. Its course may be indicated by a line drawn from the inner side of the head of the fibula to a point midway between the two malleoli.

The anterior tibial nerve lies to the outer side of the vessel in its entire extent. In the middle it is in very close relation, getting somewhat upon its anterior surface. Venæ comites are placed upon either side of the artery, and should be separated before passing the ligature.

Course.—From the lower border of the popliteus muscle, forward through the interspace between the tibia and fibula above the upper border of the interosseous membrane, and downward on the anterior surface of the membrane to a point midway between the malleoli.

Surface markings.—Crest of the tibia and tibialis anticus muscle.

General relations.—*In front.*—Skin, superficial and deep fasciæ, tibialis anticus, extensor longus digitorum, and extensor proprius pollicis muscles, anterior tibial nerve, and anterior annular ligament.

Behind.—Interosseus membrane, tibia, and anterior ligament of the ankle-joint.

Inside.—Tibialis anticus and extensor proprius pollicis muscles.

Outside.—Anterior tibial nerve, extensor longus digitorum and extensor proprius pollicis muscles.

Guides.—Tibialis anticus, tendons of the extensor longus digitorum and extensor proprius pollicis.

Structures to be avoided.—Anterior tibial nerve and venæ comites.

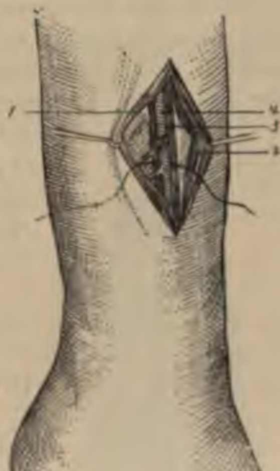
OPERATION.—*In the upper third.*—Turning the limb inward and extending it, an incision four inches in length is made over the course of the artery through the skin, midway between the crest of the tibia and the outer border of the fibula. The superficial and deep fasciæ are divided next on the director, and the septum between the tibialis anticus and extensor longus digitorum is sought for. This may be recognized as the first intermuscular space from within outward, and by a white line at the lower part of the wound. The different muscles should also be brought into action by moving the foot, which will assist in distinguishing the line of separation. Flexing the foot, so as to relax the muscles, they are separated with the handle of the knife or finger, and the artery brought into view as it lies on the interosseous membrane, embraced between the venæ comites, with the anterior tibial nerve to the outside. Separating the

veins from the artery, the ligature needle is passed from without inward.

In the middle third.—At this point the artery is reached by an incision, three inches in length, over the course of the vessel, somewhat nearer to the crest of the tibia than above, dividing the skin. The fasciæ are divided, and the artery is found on the tibia, between the tibialis anticus and the extensor proprius pollicis muscles, with the nerve lying over it. Separating the nerve from the artery, the ligature needle is passed from without inward (Fig. 281). In ligaturing the artery at this point, care should be taken to avoid making the incision too far from the crest of the tibia. It is to be remembered that the artery at this point approaches the tibia.

In the lower third.—An incision three inches in length, dividing the skin, is made along the external border of the tibialis anticus muscle to the upper margin of the anterior angular ligament, which passes obliquely across the limb from above downward, from the external to the internal malleolus. The superficial and deep fasciæ are divided carefully on the director, and the artery sought for as it lies between the tendons of the tibialis anti-

Fig. 281.



1. Extensor proprius pollicis and extensor longus digitorum muscles.
2. Tibialis anticus muscle.
3. Venæ comites.
4. Artery.

At this point of its course the
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The Dorsalis Pedis Arte
—The dorsalis pedis artery is
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Fig. 282.

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1. Anterior

drawn from a point midway between the two malleoli to the space between the first and second metatarsal bones, indicates its course.

Surface marking.—Extensor proprius pollicis muscle.

General relations.—*In front.*—Skin, superficial and deep fasciæ, inner tendon of extensor brevis digitorum muscle.

Behind.—Astragalus, scaphoid, middle and internal cuneiform bones and their ligaments.

Inside.—Extensor proprius pollicis muscle.

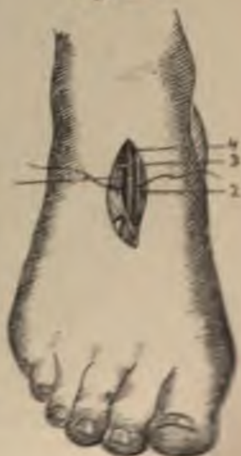
Outside.—Extensor longus digitorum muscle and anterior tibial nerve.

Guides.—Tendon of the extensor proprius pollicis muscle and inner tendon of the extensor brevis digitorum.

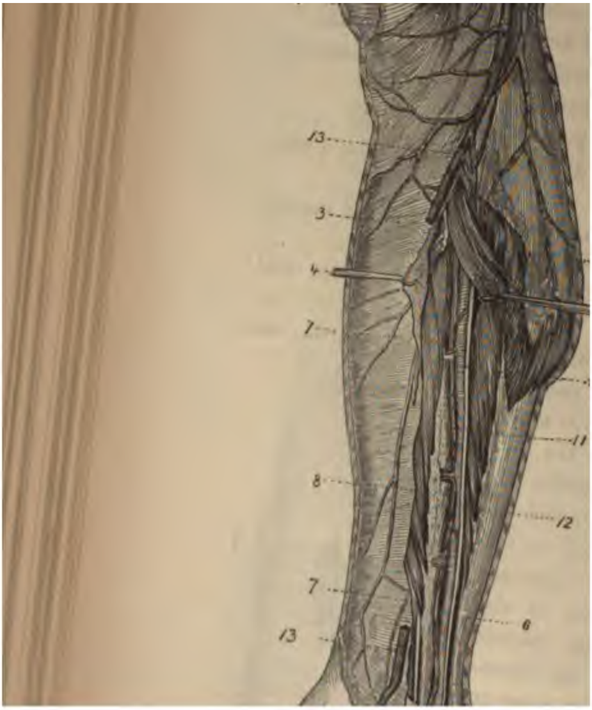
Structures to be avoided.—Anterior tibial nerve and venæ comites.

OPERATION.—An incision, two inches in length, not extending below the upper point of the first interosseous space, is made along the outer border of the extensor proprius pollicis muscle, dividing the skin. The superficial and deep fasciæ are divided on the director, and the artery exposed, lying between the tendon of the extensor proprius pollicis muscle and the inner border of the extensor brevis muscle, with the nerve to

Fig. 283.



1. Inner tendon of the extensor brevis digitorum muscle.
2. Venæ comites.
3. Tendon of the extensor proprius pollicis muscle.
4. Dorsalis pedis artery.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tween the internal malleolus and the tuberosity of the os calcis, where it terminates as the internal and external plantar arteries (Fig. 284). A line drawn from the middle of the popliteal space to a point behind the internal malleolus, will represent the direction it takes. In the upper part of its course it lies upon the tibialis posticus muscle, beneath the gastrocnemius and soleus muscles, covered by the intermuscular fascia, which separates it from the soleus.

As it descends it becomes superficial, and in the lower third passes along the inner border of the tendo Achillis, a short distance from its point of origin. The posterior tibial nerve occupies a position to the inside, then it crosses the artery, and passes on the outside in the remainder of its course. Venæ comites accompany it in its entire extent. As it passes round the heel, it lies between the tendons of the flexor longus digitorum and flexor longus pollicis, embraced between the venæ comites, with the nerve to the outside.

Course.—Obliquely downward and inward from the lower border of the popliteus muscle to a point midway between the internal malleolus and the point of the heel.

Surface markings.—Inner border of the tibia and the tendo Achillis.

General relations.—*In front.*—Tibia, tibialis posticus and flexor longus digitorum muscles, ankle-joint.

Behind.—Soleus and gastrocnemius muscles, deep and superficial fasciæ, skin.

Inside.—*Upper third.*—Origin of soleus muscle; above, to slight extent, posterior tibial nerve.

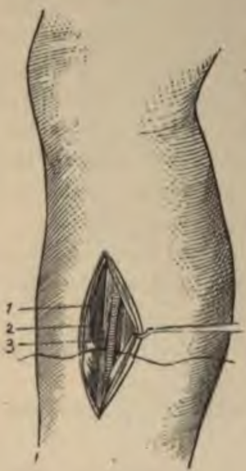
Outside.—*Lower two-thirds.*—Posterior tibial nerve.

Guides.—*Above.*—Intermuscular fascia, which separates the superficial and deep layers of muscles. *Below.*—Tendo Achillis.

Structures to be avoided.—Internal saphenous vein, posterior tibial nerve, and venæ comites.

OPERATION.—*In the upper third.*—Placing the limb on the outer side, with the leg flexed and the foot extended, so as to relax the muscles of the calf, an incision four inches in length is made along the inner border of the tibia, dividing the skin. The superficial fascia should be divided on the director, care being taken to avoid the internal saphenous vein which passes up the leg in this region between its layers. The deep fascia being divided, the margin of the gastrocnemius is exposed, which should be drawn aside, and the attachment of the soleus to the tibia divided on the director. Seeking the intermuscular septum which binds the artery to the posterior surface of the tibialis posticus, it should be divided cautiously, and the artery exposed. Increase the flexion of the leg so as to relax to the fullest extent the muscles of the calf, then separate the venæ comites from the artery, and pass the ligature from without inward, avoiding the posterior tibial nerve (Fig. 285).

Fig. 285.



1. Soleus muscle.
2. Venæ comites.
3. Artery.

The posterior tibial artery can be exposed in the upper portion by an incision on the posterior surface of the leg through the superficial muscles. This method is not advised, owing to the great amount of injury inflicted on

the structures, although drainage can be better effected than in the method of operation above described. In these operations the relations of the intermuscular septum to the artery should be remembered. The septum is a pearly white membrane which covers the artery, and which can be seen distinctly, and recognized by its color and the transverse direction of its fibres. It separates the superficial and deep muscles, and *beneath* it the artery is placed with its veins and the posterior tibial nerve.

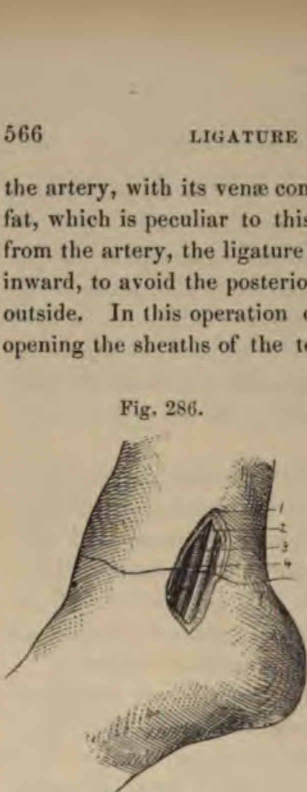
In dividing the attachment of the soleus muscle to the tibia, care should be taken to avoid severing at the same time the origin of the flexor longus digitorum. If this precaution is neglected, the substance of the muscle will be invaded and the artery missed. Its position should be remembered as being on the posterior surface of the tibialis posticus muscle, covered by the intermuscular septum.

In the middle third.—The limb being in the same position as for the ligature in the upper third, an incision three inches in length midway between the inner border of the tibia and inner edge of the tendo Achillis should be made, dividing the skin. Fixing the position of the internal saphenous vein, the superficial and deep fasciæ should be divided on the director, avoiding it. Seek the edge of the tendo Achillis, and divide the layers of fascia connected with it. The artery, surrounded more or less by fat, will be found along the inner edge of the flexor longus digitorum, accompanied by its veins, with the nerve to the outside. The ligature should be passed from without inward, avoiding the nerve.

In the lower third.—An incision two inches in length is made along the inner border of the tibia, and three-quarters of an inch posterior to it, dividing the skin. The sheath of

the artery, with its venæ comites, will be found imbedded in fat, which is peculiar to this region. Separating the veins from the artery, the ligature should be passed from without inward, to avoid the posterior tibial nerve, which lies to the outside. In this operation care should be taken to avoid opening the sheaths of the tendons which are placed on the posterior surface of the tibia (Fig. 286).

Fig. 286.



1. Skin and fasciæ.
2. Posterior tibial nerve.
3. Venæ comites.
4. Posterior tibial artery.

At the ankle.—A semilunar incision two and one-half inches in length should be made midway between the internal malleolus and the heel, dividing the skin. The strong and dense fascia (the internal annular ligament) covering the vessels and nerves, which is now exposed, and which is closely adherent to the sheaths of the tendons, should be divided cautiously on the director. The sheath of the vessels should be opened, the venæ comites separated from the artery, and the ligature passed from below upward, avoiding the posterior tibial nerve.

The Peroneal Artery.—SURGICAL ANATOMY.—The peroneal artery arises from the posterior tibial and passes down the posterior surface of the leg along the outer or fibular side, terminating in branches on the back and outer

side of the ankle. A line drawn from the posterior part of the head of the fibula to the external border of the tendo Achillis at the malleolus will indicate its course.

Course.—From point of origin from the posterior tibial artery an inch below the lower border of the popliteus muscle, obliquely outward to the fibula, descending along its inner border to the ankle (Fig. 280, 14).

Surface marking.—The fibula.

General relations.—*In front.*—Tibialis posticus and flexor longus pollicis muscles.

Behind.—Soleus and flexor longus pollicis muscles, fasciæ, and skin.

Outside.—Fibula.

Guide.—Flexor longus pollicis muscle.

Structures to be avoided.—The peroneal nerve.

OPERATION.—An incision three inches in length, parallel with, but behind, the external border of the fibula, should be made, dividing the skin. The attachment of the soleus muscle to the fibula must be divided, if necessary, and the muscle drawn inward. The origin of the flexor longus pollicis is to be detached, and the artery will be found to the inner side, lying beneath a strong aponeurosis on the anterior surface of this muscle, which must be divided. The ligature should be passed so as to avoid the peroneal nerve.

PART V

AMPUTAT

AMPUTATIONS are operations wl
purpose of removing a limb or a
body. The point of separation n
tinuity of the limb, through the bo
between two or more bones.

Conditions demanding Amputati
rule, required in those cases in wl
part, whether as the result of injury
jeopardize the life of the patient or
loss of the limb, by the adoption of
of treatment. In every case of very
involving a limb, the best judgmen
upon his knowledge and experience
arriving at a decision. It is, freq
point to decide whether a patient
attendant shock of an amputation ...

of the individual as well as his status in life should enter somewhat into the decision. To a working man, an artificial appliance even if of rudest construction, will be of more service than the natural limb preserved in a deformed and useless condition.

The conditions which call for amputation include injuries and diseases of the *soft structures*, of the *bones* and *joints*, *malformations*, *deformities*, *aneurisms*, and *gangrene*.

The injuries of the soft tissues which may require amputation embrace extensive lacerations and contusions involving bloodvessels and nerves, the results of the application of force, or gunshot wounds. The diseases which may necessitate removal of the part or limb are generally of a malignant character. Non-malignant growths, when of large size, may demand amputation by reason of the pressure exerted. When amputation is performed for malignant tumors, the section should be made some distance from the seat of the disease.

The injuries of the bones which require amputation are associated usually with those of serious injuries of the soft tissues, as compound and comminuted fractures, the result of railroad crushes or severe gunshot wound. Where it is necessary to transport a patient some distance, as in military campaigns, it may be, in many instances, more prudent to amputate the injured limb than submit the patient to the dangers resulting from the motion and jarring incident to transportation over rough roads. Extensive necrosis, osteomyelitis, and malignant tumors of the bone, as well as ulcers, malignant and specific, of the soft tissues which involve the bone secondarily, demand amputation.

Compound dislocations are sometimes of such gravity, by reason of complications, as to require amputation, especially those of the knee-joint. In diseases of the joints, amputa-

be removed without danger at

Deformities, which are at the s
and which cannot be relieved b
dons, demand amputation.

Aneurisms sometimes require
secondary hemorrhage, following
formed for its relief, or rupture o

Rupture, caused in the efforts a
complete division of the main arte
gunshot wound, call frequently for

Gangrene, consequent upon inj
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In traumatic conditions ampu
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it cannot be avoided, as may happen in accidents in which the patient may not obtain the services of the surgeon until the primary stage has elapsed, and the conditions are such as to demand immediate interference.

The *secondary* period is that in which the inflammation has passed to the stage of suppuration, the acute symptoms having measurably subsided. While this stage offers better prospects of success than the intermediary, it is still an unfavorable one, owing to the state of exhaustion which exists after the subsidence of the active inflammation. In this stage, tonics and good diet will improve the patient's condition and place him in a more favorable state for operative interference. Patients are frequently permitted to pass into this stage on account of the opposition of the patient or of his friends to the performance of amputation when the primary stage is present.

INSTRUMENTS USED IN AMPUTATIONS.

The instruments and appliances required in performing these operations are knives, saws, bone-nippers, dissecting forceps, artery forceps, tenaculum, ligatures, sutures, suture-needles, scissors, retractors, and tourniquet.

1. *Knives.*—These consist of amputating knives, large and small, the catlin, bistoury, and scalpel.

The *amputating knives* may vary in length from seven to twelve inches; in width, from three-eighths to three-quarters. They should have thick backs, the principal cutting edge extending the whole length of the blade, and the edge upon the back not longer than an inch and a half. They should be mounted in strong and roughened handles (Figs. 287, 288, 289).

Figs. 294. 293. 292. 291. 29

putations of the forearm and leg. It can be dispensed with, the bistoury or scalpel accomplishing this portion of the operation equally well. It should not be used to make flaps by transfixion, as the borders are liable to be cut in a jagged manner by the double cutting edge of the instrument.

Fig. 295.

Fig. 296.

Fig. 297.

The *bistoury* should have a narrow, sharp-pointed blade three inches in length, with a strong back to it (Fig. 291).

The *scalpel* should have a strong blade three inches in length, with a broad body and a sharp point (Fig. 292).

2. *Saws.*—These may be of two kinds. The one for larger bones should be ten inches long by two and a half wide; strong, with heavy back, and teeth not too widely set (Fig. 295). For the bones of the hand, a small saw, called the metacarpal saw, is employed (Fig. 296). A small saw, with a movable back, is used for the foot (Fig. 294).

3. *Bone-nippers* or *cutting pliers* are used for dividing the bone in amputation of phalanges or cutting off rough edges left by the saw. The blades should be short and sharp, and the handles long and strong (Fig. 297).

4. *Artery Forceps* are used to seize the divided vessels. The blades should be *toothed*, so as to hold firmly, and ex-

Fig. 298.

Fig. 299.

panded a short distance above the point, in order that the ligature may slip over easily, and not include the point in the knot. They should fasten with a spring or catch (Figs. 298, 299).

5. The *Tenaculum.*—A sharp, slightly curved hook (Fig. 300). This is used to penetrate the coats of the vessel and hold it while the ligature is applied, or to pick up a mass of tissue when it is not possible to isolate the artery.

6. *Ligatures, sutures, suture needles,* and *scissors* have already been described (pp. 479–486).

Fig. 300.

7. *Retractors.*—These are formed from pieces of st muslin, six to eight inches wide and of proper length to embrace the limb, one end being torn into two or three tails. They are applied around the bone to retract the

Fig. 301.

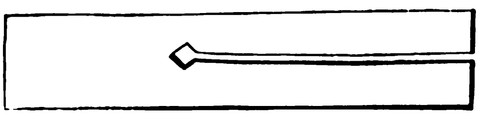
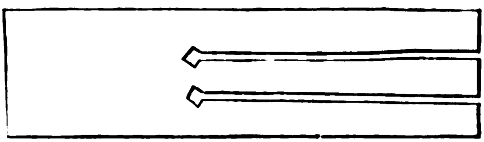


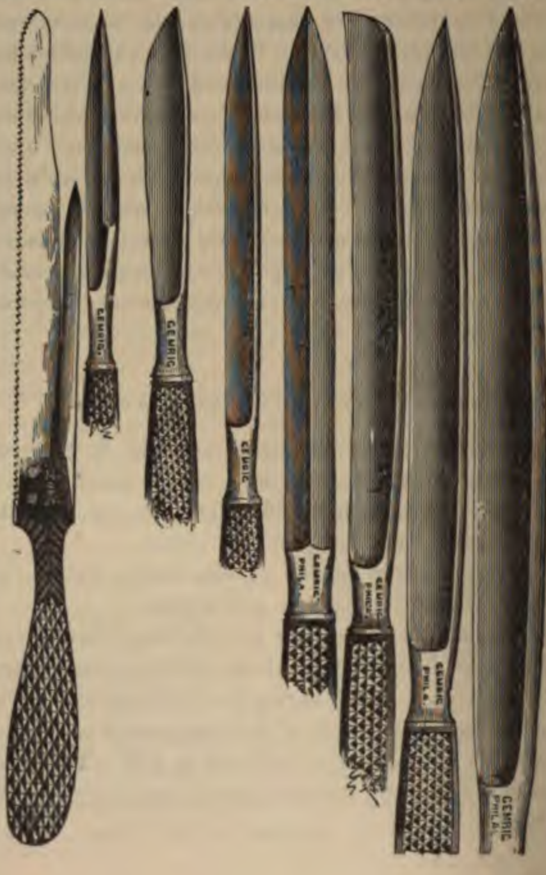
Fig. 302.



soft structures, and prevent injury to them by the saw, and also to protect them from the bone dust (Figs. 301, 302).

The *catlin* or *double-edged knife* (Fig. 290) is used, and forms part of the operating cases; it is employed to divide the interosseous membranes and intervening tissues in am-

Figs. 294. 293. 292. 291. 290. 289. 288. 287.



putations of the forearm and leg. It can be dispensed with, the bistoury or scalpel accomplishing this portion of the operation equally well. It should not be used to make flaps by transfixion, as the borders are liable to be cut in a jagged manner by the double cutting edge of the instrument.

Fig. 295.

Fig. 296.

Fig. 297.

The *bistoury* should have a narrow, sharp-pointed blade three inches in length, with a strong back to it (Fig. 291).

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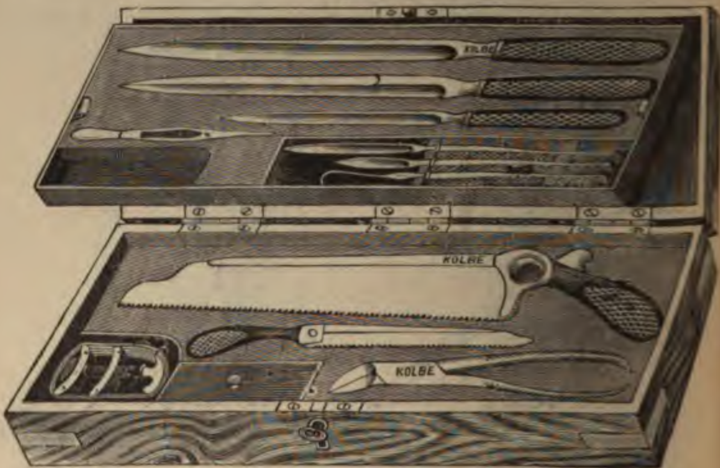
Fig. 295.

Fig. 296.

Fig. 297.

The *bistoury* should have a narrow, sharp-pointed blade three inches in length, with a strong back to it (Fig. 291).

Fig. 311.



putations are arranged in a convenient manner in the amputating-case (Fig. 311).

METHODS OF AMPUTATION.

There are two principal methods of amputation; the circular and the flap. The oval may be regarded as a variety of the circular, and the rectangular of the flap method.

The Circular Method.—This operation may be described as consisting of three stages.

The first stage includes the division of the skin and superficial fascia; the second, that of the muscles and other structures to the bone; and the third, section of the bone.

In performing the operation, the operator stands so as to enable him to grasp the proximal part and retract the superficial tissues with the left hand; then, stooping so as to place his face on a level with the limb, he carries the amputating knife, held lightly in the right hand, around to the opposite side of the limb until the blade is perpendicular to the floor, pressing the heel firmly into the tissues (Fig. 312). He

Fig. 312.

then makes a circular cut around the limb, rising as he makes it, so as to complete the entire incision with one motion.

Separating the skin and fascia by careful dissection (Fig. 313), to the extent of two or two and a half inches, the cuff or fold thus formed is turned back, and the knife is carried about the limb just below its border in the same manner as above described, dividing the muscles and other structures to the bone. A circular sweep is now made around the bone, dividing the periosteum, which, with the muscular structures, is dissected up to the extent of an inch

or more. The retractor is now applied, the tails being directed upward, and crossed in such manner that they, with the body of the retractor, completely cover the cut surfaces. The tissues being firmly pressed back, the saw, held *vertically*, is applied to the highest point exposed

Fig. 313.

Fig. 314.

(Fig. 314), and drawn from heel to point, steadied carefully by the thumb-nail of the left hand, and the bone divided by short, light, and even strokes. If two bones are to be sawn, the saw should be used so that the smaller and most movable shall be divided first.

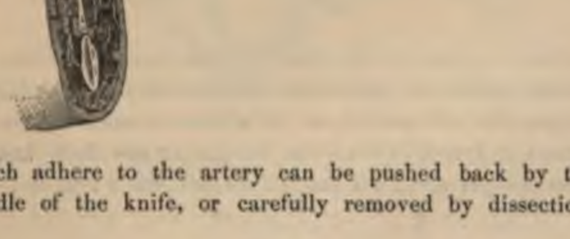
The vessels are now to be ligatured, spicula of bone (if any exist) removed by the bone nippers, the projecting ends of nerves and tendons retrenched, and the edges of the fold of skin brought into apposition transversely, and fastened together by means of sutures.

In applying ligatures to the arteries after amputation, the divided end is to be seized with the artery forceps (Fig.

Fig. 315.

315) or transfixed by the tenaculum, and *drawn out* (Fig. 316) from the tissues so as to isolate it—any structures

Fig. 316.



which adhere to the artery can be pushed back by the handle of the knife, or carefully removed by dissection.

Great care should be taken to avoid the inclusion of the nerve in the ligature, else the most serious consequences may ensue, such as secondary hemorrhage or tetanus. It is important that the end should be cut across straight, and not obliquely, and that the ligature should be applied a sufficient distance from the divided end to insure complete occlusion of the vessel. One end of the ligature should be cut off close, and the other brought out between the flaps at the nearest point to the surface. The most important vessel may be indicated by a knot tied in the ligature, or the two ends may be allowed to remain, and be then knotted.

It is important that the ligature should be applied securely to the artery, and to accomplish this the reef-knot should always be used. To tie this knot successfully the following

Fig. 317.

method is given by Mr. Heath. The ligature is to be held in the palm of the right hand between the thumb and index finger, the end is then to be thrown around the forceps closely and caught with the left hand; the right hand is now brought under the end in the left, when that end is to

be crossed over the right thumb and inserted between the third and fourth fingers of the right hand (Fig. 317), the

Fig. 318.

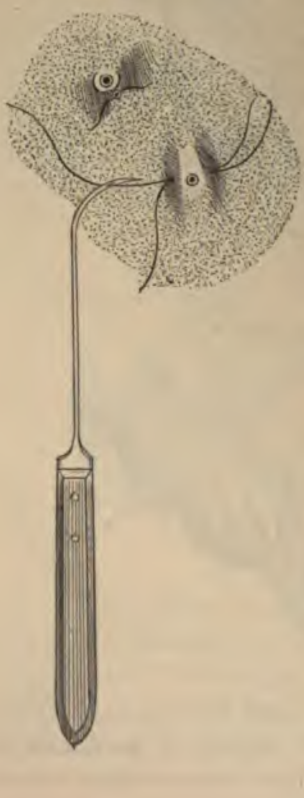
Fig. 319.

left hand at the same moment seizes the outer end, and thus an interchange is effected, and the ends of the threads are drawn out (Fig. 318). The index fingers or thumbs can be

used to draw this knot tight (Fig. 319). The knot is completed by another tie, the same manœuvre being effected, taking care to begin with the *opposite* hand to that which began before.

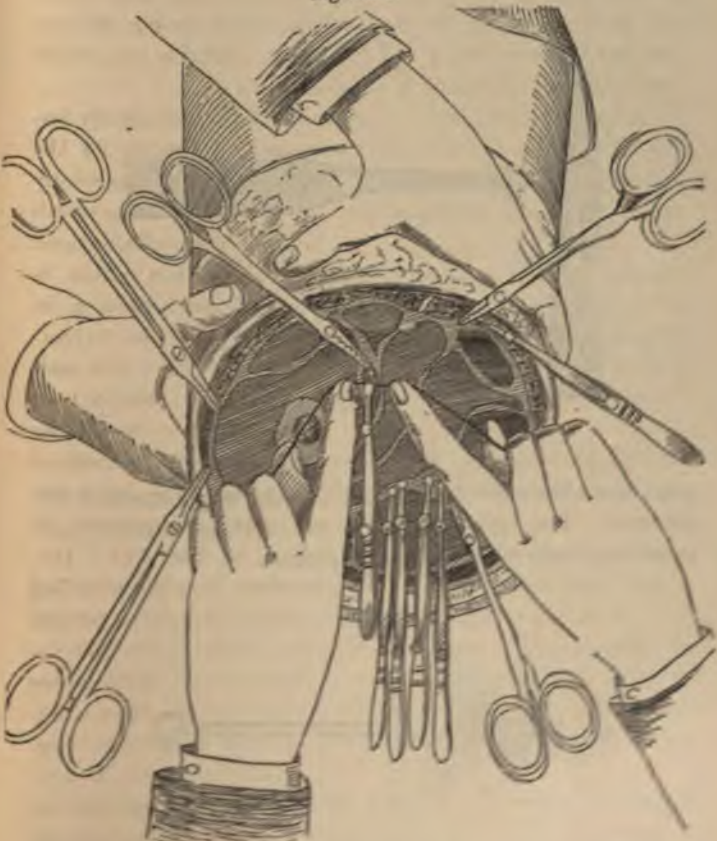
Where the cut end of the artery is short and deeply imbedded in the tissues the ligature may be applied by transfixing the tissues with a handled needle, armed with a ligature which is deposited as is shown in Fig. 320. The double ligature should be cut and each half tied and then a turn should be made around the entire vessel. The method of applying hæmostatic forceps after amputation is shown in Fig. 321. Hemorrhage may be controlled in some instances by torsion (Fig. 322), or by the introduction of acupressure pins, of which different methods are employed (Fig. 323).

Fig. 320.



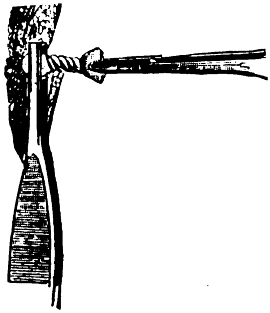
As the ligatures are liable to become adherent to the dressings, it is a good plan to fasten them to the surface by short pieces of adhesive plaster, so as to

Fig. 321.



prevent them from being pulled upon when the dressings are removed.

The projecting ends of the nerves should be removed, in order to prevent them from being held between the flaps,



and thus, after union has occurred,
pressure. The tendons should be c
sence interferes with the healing pı

Fig. 323.

times that the incisions are not made successfully because the knife is drawn around the part, *the heel alone being kept in contact with the surface.* The knife should be drawn gradually from heel to point as it passes around the limb, finishing the cut with the point. The amount of pressure to be employed varies somewhat with the condition of the part and of the knife, whether sharp or dull. Practice alone will enable the operator to acquire proper knowledge upon this point.

Before making the second incision, it is directed that the cuff of skin and fascia, which has been formed, should be turned up. In some cases, owing to the conical shape of the limb, this may be difficult to accomplish. When it is found difficult to turn this back, it should be slit open at one side.

In making the second incision, the assistant should hold back the cuff, so as to avoid its section as the knife is carried around the limb.

The periosteum is directed to be dissected up to some distance; this is desirable, in order to secure good repair in the divided end of the bone and prevent exfoliation.

In sawing the bone the saw should be held vertically, so as to divide it from side to side, and thus avoid a liability to fracture or splintering. Proper care should always be taken in supporting the portion to be removed during this part of the operation.

The manner in which the limb is held and supported is of great importance, as splintering and fracture occur frequently from want of proper knowledge upon this point. The limb should be covered with a towel or bandage, so that a firm grasp can be taken; and, while it is firmly supported, without being raised up or down, it should be drawn

away with moderate force from the body in the line of its long axis. This action will cause a separation of the ends, and prevent binding of the saw, while steady support combined with it, will remove the weight of the limb.

The circular method of amputation can be employed at any part of the limb; it is preferably used where there are two bones or an absence of muscular structures, as in the lower portions of the forearm and leg.

The Modified Circular Method.—This name is given to an operation which consists in forming two short

Fig. 324.

flaps of skin and superficial fascia by cutting from without inward, and dividing the muscles by a circular incision (Fig.

324). It may be employed in cases where there is a redundancy of muscular tissues.

The Flap Method.—Amputation by the flap method consists in the division of the tissues so as to form one or more flaps, with which the end of the bone is covered. These flaps may be made by cutting from *without inward* to the bone, or from *within outward*, the knife transfixing the tissues, and cutting from the bone to the surface. In some instances, one flap is made in the first way, and the other in the second. The flaps may vary in number from one to two or more, according to the circumstances of each case. The length also varies according to the size of the limb. A safe rule to adopt is to make them equal in length to three-quarters the diameter of the limb at the point of section of the bone. They may be made antero-posteriorly, laterally, or obliquely, and may include all of the structures to the bone, or may be made of skin and fascia alone, the muscles and other structures being divided circularly. They may be cut of equal length, or one may be longer than the other, according to the amount of muscular tissue in the part involved. They are, as a rule, convex in shape, terminating in a point more or less oblique. Care should be taken to avoid making them too oblique; and it should be remembered that it is always better to have an abundance of tissue rather than too small an amount. In the one case the redundant tissue can be retrenched; in the other it may be found difficult to supply the deficiency. If, in any case, the flaps are found to be too short, and there is danger of protrusion of the bone, the bone should then be sawn through at a higher point.

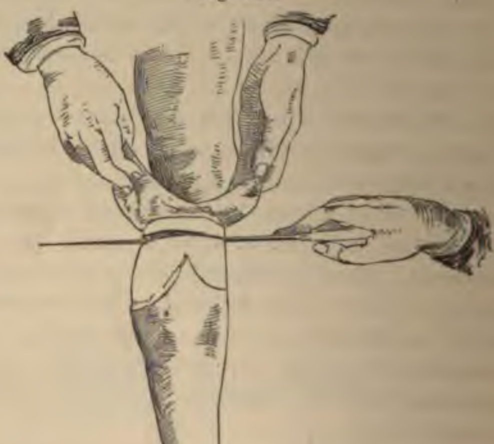
In performing the operation by transfixion the operator stands so as to grasp the proximal part of the limb firmly

away with moderate force from the body in the line of its long axis. This action will cause a separation of the ends, and prevent binding of the saw, while steady support combined with it, will remove the weight of the limb.

The circular method of amputation can be employed at any part of the limb; it is preferably used where there are two bones or an absence of muscular structures, as in the lower portions of the forearm and leg.

The Modified Circular Method.—This name is given to an operation which consists in forming two short

Fig. 324.



flaps of skin and superficial fascia by cutting from without inward, and dividing the muscles by a circular incision (Fig.

324). It may be employed in cases where there is a redundancy of muscular tissues.

The Flap Method.—Amputation by the flap method consists in the division of the tissues so as to form one or more flaps, with which the end of the bone is covered. These flaps may be made by cutting from *without inward* to the bone, or from *within outward*, the knife transfixing the tissues, and cutting from the bone to the surface. In some instances, one flap is made in the first way, and the other in the second. The flaps may vary in number from one to two or more, according to the circumstances of each case. The length also varies according to the size of the limb. A safe rule to adopt is to make them equal in length to three-quarters the diameter of the limb at the point of section of the bone. They may be made antero-posteriorly, laterally, or obliquely, and may include all of the structures to the bone, or may be made of skin and fascia alone, the muscles and other structures being divided circularly. They may be cut of equal length, or one may be longer than the other, according to the amount of muscular tissue in the part involved. They are, as a rule, convex in shape, terminating in a point more or less oblique. Care should be taken to avoid making them too oblique; and it should be remembered that it is always better to have an abundance of tissue rather than too small an amount. In the one case the redundant tissue can be retrenched; in the other it may be found difficult to supply the deficiency. If, in any case, the flaps are found to be too short, and there is danger of protrusion of the bone, the bone should then be sawn through at a higher point.

In performing the operation by transfixion the operator stands so as to grasp the proximal part of the limb firmly

with the left hand. Raising the tissues so as to see that the flaps to be made will be, as nearly as possible, of equal size, the point of the amputating knife is entered on the side, midway between the upper and lower borders of the limb, and pushed inward until it strikes the middle of the bone. The handle of the knife is then depressed until the point is carried over the bone, and then elevated, returning the blade to the horizontal position, in order to bring the point out exactly opposite to the point of entrance. The knife, still in the horizontal position, and in close contact with the bone, is carried downward with a sawing motion to a sufficient distance, and then turning its edge to about an angle of 45°, it is carried upward and outward until the tissues are divided. In cutting outward, the handle of the knife should be gradually turned in the hand, so that when the edge leaves the tissues it will look directly upward. In this way, a pointed flap will be avoided. Turning back the flap, the knife is re-entered at the same point as before, carried under the bone by movements similar to those used in making the first flap, the point brought out as before (Fig. 325), and the flap cut in the same way as the first. The flaps are now held back by the retractor, and the remaining tissues and

Fig. 325.

periosteum divided by a circular cut of the knife. The periosteum is dissected back to a sufficient extent, and the bone sawn. The arteries are ligatured, nerves and tendons retrenched, and sutures introduced, as described in the circular method.

In transfixing the tissues in this operation in the arm and thigh, it is important that the principal artery should not be pierced by the point of the knife in making the first flap, as a punctured wound or a longitudinal slit will be made in the vessel which may cause serious trouble, the operator being compelled to dissect back to a sound portion of the artery in order to apply the ligature. If the position of the main artery is well ascertained before the incisions are commenced, the point of the knife can be passed so as to avoid it. An effort should always be made to leave it in the flap which is made last thus deferring its division to the later stages of the operation.

In the arm and thigh, where the superficial fascia is usually abundant and the skin is very elastic and moves readily over the subjacent muscular tissues, care must be taken, in cutting from within outward, to retract the skin firmly, so that when the section is completed the muscles and skin will be divided on the same line. If this important injunction is unheeded, the operator will find a projecting mass of muscular tissues without sufficient skin to cover them. This mass should be retrenched, otherwise, if an attempt is made to pull the skin forcibly over it and then apply sutures, these will cut through, owing to the undue tension. It may be advisable, in some instances, when cutting from within outward, to turn the knife so as to divide the muscles at a higher point than the skin, thus reducing the muscular mass in the flap and giving a longer skin flap.

In forming antero-posterior flaps by transfixion, the anterior flap should be made first. In the lateral flap operation, the outer flap should be cut first. As a rule, the principal artery should be contained in the flap formed last.

An effort should be made, in cutting the flaps in the living subject, to form them with regard to shape and size, so as to obtain a stump to which an artificial appliance can be adapted with comfort to the individual, the line of the cicatrix being so placed as to be free from pressure.

In the flap method, the flaps may also be made by cutting from without inward. When this plan of forming them is adopted, the amputating knife or, if preferred, a large scalpel, should be entered on one side, at the point fixed upon for section of the bone, and carried over the front of the limb, making a curvilinear incision downward to the extent necessary to give proper length to the flap, bringing it out at a point just opposite to that of entrance. With this incision, the skin and superficial fascia, or the entire structures to the bone, are divided. The posterfor flap may be formed in the same way, or by transfixion.

The Oval Method (Scoutetten's method).—This method, as stated above, may be regarded as a modification of the circular. It may be employed when amputation is performed in the continuity of a limb, but it is more frequently adopted in disarticulations or amputations through the joints. The incision is made by introducing the knife a few lines above the point of section of the bone or above the joint, carrying it downward in a vertical line for a short distance, and then sweeping it about the limb in an oblique direction, dividing all the structures to the bone, and re-

turning to the point of entrance. It may also be made by two incisions in the shape of the letter V reversed, these being made first and then united by a transverse cut.

The Rectangular Flap Method (Teale's method).—This is a modification of the double flap, and consists in forming two rectangular flaps, a long and a short one. The length and breadth of the long flap should be equal to *one-*

Fig. 326.

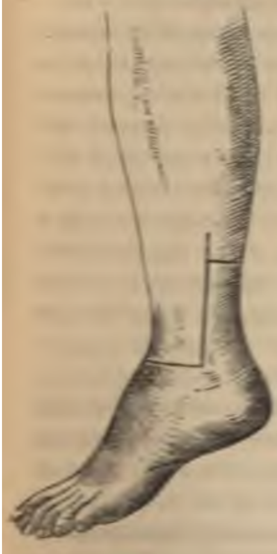


Fig. 327.

Fig. 328.

half (preferably one-third) *the circumference of the limb* at the point of section of the bone, and the short flap, which *should contain the vessels*, should measure *one-eighth the circumference, or one-fourth the length of the long flap.* The

spicula (Fig. 327). Th
end of the bone, and att
the end and sides. Th
should also be secured by

The different methods o
be employed with advanta
When thus employed they
pose of a covering to the di
have been urged against tl
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circular method to fashion tl
little consequence so long as
ence of an anæsthetic. The
deep fascia causes the divi
vessels, and leaves it depend
point of reflection, which m
nutrition in long flaps and in
of the parts has occurred. It
the turning over of the flap a
at the time to incise it. The
the absence of danger of
a conical

owing to the large cut surfaces. The large muscular cushion left after the flap operation, and which is claimed as an advantage, gradually undergoes atrophy, leaving in its place a mass of connective tissue.

The great objections to the rectangular flap is the large surface divided and the amount of bone removed. The special methods of operation upon the foot and at the various articulations are modifications of the principal varieties adapted in each case to the configuration of the part.

After treatment.—Hemorrhage having been controlled and the flaps adjusted by sutures, and, if necessary, supported by adhesive strips, the dressings should be applied. Much stress was laid formerly on the importance of allowing the wound to remain unclosed or partially closed until all apprehension of hemorrhage had passed away and the surface had become glazed with a layer of lymph. The edges were then approximated and the stump was dressed with the dry or wet dressings.

The introduction of the antiseptic methods of wound treatment has effected a change, in the opinion of surgeons, with regard to the necessity of delay in applying the permanent dressings after amputation and in the character of dressings employed. The use of antiseptic agents at the time of the operation, the thorough drainage of the wound by the introduction of drainage tubes, whereby the wound fluids are immediately removed and disinfected in the dressings, with the accurate apposition of the cut surfaces by the employment of the various forms of sutures of coaptation, approximation, and relaxation, remove to a great extent the causes which give rise to unfavorable conditions during the progress of the after-treatment. While it is important that all oozing of blood should cease and that all clots should be carefully removed

tissue. The occurrence of thes
antiseptic methods should not,
of the surgeon in all efforts to ob
hemorrhage following operation
ligatures or other means before c

When the antiseptic dressing
should be ligatured by carbolize
the former of which should be
in the same manner or brough
the nearest points. The surfac
thoroughly douched with the car
tion, a drainage tube should be
of the wound between the flaps,
at each angle and secured by a
off close. The flaps should now
in contact by an assistant, whil
introduced. Carbolated or su
now be thrown through the dra
interior of the wound. If deeme
sive plaster may be employed to
and th
dressin

Fig. 329.

tected from pressure of the bedclothes by a frame (Fig. 329). Redressing should not be made before the expiration of four to six days, the temperature record being the guide for the surgeon in this respect. If the temperature remains uniform or with slight variation the dressings should not be disturbed until the fifth to the sixth day, at which period the process of repair is well advanced. After this the dressings should be renewed in accordance with the amount of suppuration, if that has occurred, or the necessity for the removal of sutures or ligatures. Both should be gradually removed, the former when they have ceased to afford support to the edges or are cutting through the tissues, and the latter from time to time as they show on slight traction a disposition to separate. The ligature upon the main artery should be allowed to remain for a longer period than the smaller branches, and traction should be made very cautiously lest it be detached prematurely and fatal hemorrhage occur.

Treatment by "pneumatic aspiration" or by the "open method" may be employed if deemed advisable. The former mode of treatment, devised by Maisonneuve, is designed to exclude the air from the stump, the flaps of which are held together simply by adhesive strips, and consists "in surrounding the stump with a closely-fitting hood of vulcanized rubber, to the centre of the free extremity of which is attached a tube of similar material, from two to three feet in length, the opposite end of which is fitted, by means of a metallic canula, in a rubber plug secured in a gallon glass jar. A second metallic tube pierces the rubber plug, and is connected with a vulcanized tube of convenient length attached to a brass exhausting pump. A few strokes of the piston, morning and evening, suffice to draw the discharges from

ment. It is necessary that
treated by this plan, should
account of the great shrinka
large. In the method, as pr
Wood, of New York, "the w
after the operation with a
carbolic acid and then filled w
age being accomplished by t
oakum soaked in the balsam.
painful from overaction the
it is allowed to remain undis
After this the wound is douc
solution of carbolic acid, and
as in the first instance. At t
day, when suppuration has
moulded into shape and gradu
sive strips." This method of
Prof. Gross, is not liable to
close dressing, by erysipelas,
or suppurative fever.

Affections of the Stump.—
secondary, and *local* or *loca*
origin.

Hemorrhage of slight character is liable to follow in every case of amputation and to stain the dressings more or less. This form of hemorrhage does not require any special attention. When, however, the dressings are soaked with blood of a red or dark color they should be immediately removed and attention should be given to the source of the bleeding. Primary hemorrhage may occur from an artery which did not bleed at the time of the dressings and to which a ligature was not applied; from an artery cut obliquely and, as a result, imperfectly ligatured; from a vessel in a state of disease or from one imbedded in inflamed tissues; and it may also take place from the vessels of the Haversian canals. Efforts should be made to arrest the hemorrhage by elevation of the stump, the application of cold and digital compression of the main artery, combined with compression of the stump by a firmly applied bandage. If these measures do not succeed the flaps should be separated to sufficient extent to secure the bleeding vessel with a ligature. Hemorrhage from the divided bone may be arrested by pressure made with a compress of lint to which a thread is tied, applied directly to the part, or the bleeding points may be plugged with pieces of catgut ligature, beeswax, or a plug of soft wood, sufficiently long to project beyond the edges of the flaps, and which may be withdrawn in a few days. The application of caustics should not be made lest necrosis be induced.

Spasms of the muscles are very liable to occur after amputation especially in nervous subjects and should be allayed by the hypodermic injection of morphia. The spasms are frequently accompanied by excessive pain, which should be relieved promptly by morphia.

Erysipelatous inflammation, a frequent complication of amputations under the old form of dressings employed, is not

liable to occur under antiseptic methods. In case of its occurrence it should be treated by constitutional and local remedies. If excessive suppuration occurs the pus should be conducted from the wound by drainage-tubes and frequent douching of warm antiseptic lotions should be made.

Gangrene, liable to occur in debilitated subjects and in badly ventilated and crowded hospitals, should be treated by the internal administration of stimulants and tonics and by the local application of counter-irritants in the earlier stages, and with poultices in the later stages to facilitate the removal of the sloughs. Thorough drainage of the wound should be maintained, and antiseptic solutions should be freely employed.

Osteomyelitis may result from injury to the bone at the time of the accident or when the bone is divided by the saw in the amputation. It sometimes accompanies erysipelas and pyæmia, and is a very grave complication. It should be treated by the free use of antiseptic solutions thrown into the wound, and complete drainage to remove the wound secretions. Constitutional agents should be also employed to maintain the strength of the patient. When death of the bone occurs its removal should be delayed until the condition of the patient is sufficiently improved to enable him to withstand the shock of the operation.

Protrusion of the bone occurs as the result of inordinate retraction of the muscles, especially after amputations of the thigh, where the powerful muscles of the region are divided. The application of a firm bandage beginning above and passing downward to the end of the stump will frequently prevent retraction of the muscles. Extension by means of weights and pulley may also be employed as in fracture of the thigh. Subcutaneous section of the muscles may also

be practised if other means fail. Section of the bone at a higher point may be performed after dissection of the tissues, or re-amputation may be required to provide a satisfactory stump.

The principal *secondary* affections of the stump are secondary hemorrhage, necrosis of the bone, and neuralgia.

Secondary hemorrhage may occur from the eighth day to the second or third week, and may be the result of premature separation of the ligature due to organic disease of the arterial walls or of sloughing caused by gangrene. It may be arrested by digital compression of the main artery of the limb, or by the introduction of an acupressure needle. If these measures are not successful, ligature of the main artery should be performed some distance above the stump. Hemorrhage sometimes occurs in connection with necrosis of the bone, and is arrested upon removal of the sequestrum.

Necrosis of the bone may occur from injury inflicted at the time of the accident or operation, as the result of excessive inflammation and suppuration, or of interference with the proper blood supply causing defective nutrition. No efforts should be made to remove the sequestrum until it is completely detached, at which period it may be accomplished by careful dissection of the soft tissues. Violence should be avoided in extracting the sequestrum lest serious hemorrhage be provoked.

Neuralgia, due to peripheral or central conditions, occurs as an affection of the stump in persons of a nervous organization, and more frequently in women than in men. The peripheral form may be the result of the pressure exerted upon the nerves of the stump by the cicatrix in the flap or by a bulbous enlargement of the ends of the divided nerves. Ordinarily the nerve ends undergo enlargement,

and give rise to no unpleasant condition. When they assume the proportions of a walnut, or even larger, forming a neuromatous tumor, as sometimes happens, they become exquisitely painful. Internal medication is usually of little avail, especially in the severer forms, nothing short of excision or, if they are multiple, amputation, affording permanent relief.

In addition to the secondary affections above mentioned, there are a number of sufficient importance to claim attention, as caries of the bone; choreaic spasms of the muscles of the stump; the formation of a bursa upon the end of the stump caused by the pressure of an improperly constructed and adapted artificial limb; a conical formation of the stump due to insufficient flap, retraction or sloughing of the flaps; fibroid, fatty, or malignant degeneration of the tissues of the stump caused by pressure of an artificial limb, or the recurrence of malignant disease; ulceration of the integumental covering of the stump, due to contracted flap or inflammation of the cicatrix; eczema of the stump, the result of irritation in the cicatrix; contraction of the tendons occurring chiefly in those of the biceps, semitendinosis and semimembranosis muscles of the thigh, and the tendo Achillis of the leg, the result usually of not maintaining proper extension during the after-treatment. Varicose enlargement of the arteries of the stump is a rare affection, due to organic disease of the arterial walls. In most of the affections above enumerated, in the severer forms, excision or reamputation is required. In eczema of the stump internal remedies with local applications are indicated, such as vaseline, with camphor and chloral to allay the itching, or carbolated zinc ointment. Subcutaneous division of the tendons should be performed in cases of contraction, and extension applied by weights and pulley.

Synchronous Amputations.—In railway accidents, especially where persons are crushed beneath the wheels of a train, two or more of the extremities are frequently involved in the injury, and require removal simultaneously. (Fig.

Fig. 330.

330.) Where two of the extremities are removed it is designated double synchronous amputation; three, triple synchronous amputation. Of the former a number of operations have been performed, some of them successfully.

Dr. James McCann, of Pittsburg, Pennsylvania, reports, in a paper read before the American Surgical Association, and published in volume 2d of its Transactions, 29 cases of double synchronous amputations performed in the Western Pennsylvania Hospital, of which 14 recovered, showing a mortality of 51 per cent. In the same paper he records a case of triple synchronous amputation performed successfully by Dr. W. B. Lowman, of Johnstown, Pa., upon a boy aged 9 years (Fig. 331). Dr. J. G. Koehler, of Schuylkill Haven, Pa., performed successfully a similar operation in 1847 upon a boy aged 13. A similar successful operation was performed by Professor Stone, of New Orleans. In 1879 Professor John Ashhurst performed successfully a double synchronous amputation on a boy thirteen years of age. In 1882 the author performed a double synchronous amputation upon a child aged eight, removing the left limb at the hip-joint, and the right in

Fig. 331.

the lower third of the femur, the result of a crush by the wheels of a railway train. The patient died in a few hours after from shock. In these cases it is deemed advisable to remove the limbs at once and then ligature the vessels in each stump, the hemorrhage in each limb being controlled by competent assistants or the abdominal tourniquet.

Re-amputations.—Under the heading of secondary affections of the stump a number of conditions were referred to in which re-amputation was demanded. The operation should not be performed until the patient's health is such as to enable him to withstand the shock of the operation and care should be taken to guard against any undue loss of blood. The operation should be performed in the same manner as the primary amputation. In chronic diseases of the bone of the stump, it is sometimes difficult to determine with regard to the propriety of disarticulation in the place of amputation in the continuity of the bone. The question must be decided in each case according to the extent of bone involved and the proximity to the articulation.

Intra-uterine Amputation.—Instances have been recorded of amputation of the limbs of the *fœtus in utero*. One, two, or all of the limbs may be removed, the separation being either partial or complete. It is the generally accepted opinion that the amputation is produced by a band of false membrane which surrounds the limb, and by its contraction gradually severs the tissues.

Constitutional effects.—Amputations are [illegible] followed by grave constitutional effects [illegible] complicate the results, such as *shock*, [illegible] and *tetanus*. These [illegible] general principles, the last [illegible] any plan. Precautions [illegible]

the patient to the direct currents of cold air, which is liable to induce tetanus. The author was called to see in consultation a case, some years since, of tetanus following amputation at the elbow-joint. Death ensued, and an examination showed that the condition had been caused by ligature of the median nerve.

The *mortality after amputations* is influenced by various conditions—as the age, habits, occupation, and general health of the patient; the cause of the operation, whether performed for an injury or disease, the nature, extent, and situation of the operation, the hygienic conditions which surrounds the patient; the proximity of the amputation to the trunk —whether a primary, intermediary, or secondary operation; the conduct of the after-treatment—all of these conditions influence largely the results of amputations. The statistics gathered from all sources, civil, military, private, and hospital, show that the mortality of amputations performed after injuries is greater than those in disease. Primary operations are, as a rule, less fatal than secondary, and amputations of the lower show a larger mortality than those of the upper extremity. The mortality in amputations of the superior extremity for gunshot injuries is shown by the tables of Prof. S. W. Gross to be 27.42 per cent., and of the inferior extremity 55.76 per cent.

The principal points to be observed in performing amputations may be embraced in a few general statements:—

I. The patient or subject should be placed in the recumbent position; the operator should take a position which will permit him to control his movements without restraint. The table should be firm and high, so as to prevent motion and unnecessary fatigue to the operator in bending over it.

II. The assistants should perform the duties assigned them with promptness; no delay on their part should attend the delivery of the instruments as they are required, the supply of sponges in proper condition, the supply and the proper application of the ligatures. Perfect quietude should be maintained, and no conversation should be indulged in except that which relates to the performance of the operation in hand. The office of the assistant who administers the anæsthetic agent is a most responsible one; his entire attention should be given to the duty assigned him. He should carefully watch the state of anæsthesia in which the patient is placed, as manifested by the circulation, respiration, and other symptoms. He should endeavor to maintain a uniform effect upon the patient of the agent used; under no circumstances should he leave the patient or take part in any of the other duties of the operation.

III. The proximal part should be grasped firmly, and the integument drawn upward so that sufficient length will be given to this portion of the flap. Care should always be taken to cut the flaps of sufficient length. Redundant tissues should be retrenched. Flaps cut too short require section of the bone at a higher point.

IV. As a general rule, as little of the bone as possible should be sacrificed. In amptations for the removal of diseased structures, it is important to cut through the bone at a point sufficiently beyond the disease to insure healthy flaps. In injuries, on the contrary, all of the soft structures remaining should be utilized in forming the flaps, and as much of the bone saved as possible.

V. The periosteum should be dissected up to the extent of an inch or more, so as to assist in the reparative process which occurs about the end of the bone.

VI. The bloodvessels requiring ligature should be com-

pletely isolated before the ligatures are applied. Great care should be taken to avoid the inclusion of the nerve in the ligature. The projecting ends of the nerves and tendons should always be cut off.

VII. In approximating the edges of the flaps, the sutures should be introduced to such depth as is necessary to afford proper support. In removing the sutures, they should be cut with the scissors at the side, just beyond the edge of the wound, and withdrawn, the borders of the wound being supported by the thumb and index finger of the free hand. If wire sutures are used, they should be divided in the same manner, or untwisted, the cut, or free, ends being bent back so as to straighten them, and the suture removed by gentle, even traction; usually more force is required to remove the wire suture, and, therefore, care should be taken to support carefully the edges of the wound.

SPECIAL AMPUTATIONS.

THE LOWER EXTREMITY.

Amputation of the Foot.—SURGICAL ANATOMY.—The foot is the terminal part of the lower extremity, and consists of three portions, the tarsus, metatarsus, and phalanges (Fig. 332).

Bones.—The *Tarsus* is composed of seven irregular bones, the os calcis, astragalus, cuboid on the outside, scaphoid on the inside, internal, middle, and external cuneiform bones, placed between the cuboid and the inner border of the foot.

The *Metatarsus* consists of five bones, numbered from within outward, and classified as long bones.

The *Phalanges* are fourteen in number, two for the great toe and three for the remaining toes, and are enumerated

from the metatarsus. These are also classified as long bones.

Ligaments.—The bones of the tarsus are attached to each other by strong dorsal, plantar, and interosseous ligaments, with intervening synovial membranes. The articulations between the various bones of the tarsus are of the diarthrodial form, embracing the arthrodia and the enarthrosis. The metatarsal bones are united to the last row of tarsal bones and to each other by dorsal, plantar, and interosseous ligaments. They are connected with the first phalanges by an anterior plantar and two lateral ligaments.

Fig. 332.

1–5. Metatarsal bones.
6. Tibia.
7. Fibula.
8. Astragalus.
9. Os calcis.
10. Scaphoid.
11. Cuboid.
12. Internal cuneiform.
13. Middle cuneiform.
14. External cuneiform.
15–15. Phalanges.

The phalanges are bound together by plantar and lateral ligaments. Synovial membranes line the joints.

Muscles.—The upper or dorsal surface of the foot is covered by the tendons of the extensor muscles, which take origin on the anterior surface of the leg, and by the fleshy bellies of the extensor brevis digitorum.

The plantar surface or sole of the foot is well protected by the dense plantar fascia and the thick, fleshy masses formed by the flexor brevis digitorum and muscles of the great and little toes. The spaces between the metatarsal bones are occupied by dorsal and plantar interossei muscles.

Articulations.—As amputation is performed at the various articulations of the foot, it is important to study the nature

and position of these very carefully. The articulation of the phalanges with each other and with the metatarsus is quite regular, and does not differ materially from that observed in the hand. Between the metatarsus and the second row of bones of the tarsus, the line of articulation is irregular, owing to the projection backward of the head of the second metatarsal bone, and its interlocking with the three cuneiform bones (Fig. 332). The mortise formed by the three cuneiform bones has the following measurements; the internal wall is one-third of an inch deep, and has a direction obliquely backward and outward; the external wall is one-sixth of an inch deep, and its direction is obliquely backward and inward; the posterior wall measures about one-half of an inch in width, and is transverse. This position of the head of the second metatarsal bone should be particularly borne in mind in the attempts to effect disarticulation. The position of the articulation on the outside is indicated by a point just behind the tuberosity of the fifth metatarsal bone. On the inside it lies one inch in front of the tuberosity of the scaphoid.

The next line of articulation is a partial one existing between the heads of the three cuneiform bones and the base of the scaphoid, limited on the outside by the body of the cuboid. In disarticulation through the tarsus, this articulation is sometimes opened by mistake. The error can be detected at once by observing the three articulating facets on the base of the scaphoid.

The line of articulation between the astragalus and scaphoid and the os calcis and cuboid is, in its nature, compound, being convex anteriorly between the astragalus and scaphoid, and concavo-convex anteriorly between the os calcis and cuboid. On the outside, a point midway between

the external malleolus and the tuberosity of the fifth metatarsal bone, indicates the position of the articulation, while a point just back of the tuberosity of the scaphoid fixes the position on the inside.

Bloodvessels.—The arteries which supply the foot are the dorsalis pedis, on the dorsal surface, and the plantar arteries on the plantar surface, with their venæ comites. On a level nearly with the line of articulation, between the tarsus and metatarsus, the arteries form arches across the surfaces of the foot, from which are given off branches which terminate in two digital branches on each surface of the toes.

Nerves.—The nervous supply to the foot is derived from the anterior tibial and musculo-cutaneous on the dorsal surface, and the plantar nerves on the sole of the foot. Digital branches are given off, which follow the course of the arteries.

Amputation of the Toes.—*Methods.*—At the phalangeal articulations, or in the continuity of the phalanges, by the circular or flap methods. At the metatarso-phalangeal articulations, by the oval method.

OPERATION.—*Through the articulation.*—*Single flap method.*—The toe being firmly grasped and flexed, a transverse incision is made with a small narrow-bladed knife, cutting directly into the joint on the dorsal surface, over the most distinct fold which has been taken as a guide to the joint. The lateral ligaments are now to be divided, and the blade of the knife is introduced behind the head of the phalanx to be removed. The toe being extended, the knife is carried downward and forward toward the end in close contact with the bone, making a flap of the requisite length to cover the end of the bone. The digital arteries are, if necessary,

ligatured, the nerves and tendons retrenched, and the flap brought up over the end of the bone, and held in apposition by means of sutures.

Circular method.—Amputation may be performed by this method through the articulation by making an incision three or four lines below, dividing the skin. Dissecting this up to the joint, the ligaments are divided and disarticulation effected. The cuff of skin is approximated in the transverse direction.

Amputation in the Continuity of the Bones.—Either the circular or flap method may be employed in performing this operation. The incision being made and the flaps formed, as above described, the bone is divided with the small saw or cutting pliers. The flaps are held in apposition by sutures, applied as in the other forms.

Amputation through the Metatarso-phalangeal Articulation.—*By the Oval method.*

OPERATION.—The toe being flexed, the incision is made on the dorsal surface one-quarter of an inch above the joint, and carried obliquely down to the commissure, then across the plantar surface to the opposite side, the toe being extended, and thence obliquely upward to the point of departure. The extensor tendon, the lateral ligaments, and flexor tendons are to be divided in the order named, effecting disarticulation. The vessels are ligatured, the tendons and nerves retrenched, and the edges of the wound approximated in a linear direction. In this operation the head of the metatarsal bone may be removed, if deemed necessary.

Amputation of the Great Toe.—*By the Oval method.*

OPERATIONS.—1. This operation is performed by an incision beginning on the dorsum of the foot one-quarter of

an inch above the joint, and then carrying it obliquely downward and forward on the outer side of the toe to the commissure of the toes, then under the toe to the outer side, and terminating at the point of departure.

Fig. 333.

Fig. 334.

1, 2, 3, 4. Line of incision for removing first metatarsal bone with great toe.

The flap is dissected up to the joint, the extensor tendons, lateral ligaments, and the flexor tendons are divided, completing disarticulation (Fig. 333). The arteries are ligatured, the tendons retrenched, and the flaps approximated in a linear direction. In this operation the expanded extremity of the first metatarsal bone may be removed by the saw, the section being made obliquely through the bone from within outward, or the entire bone may be dissected out, the incision being carried up to the tarso-metatarsal articulation (Fig. 334).

2. The great toe may also be removed by making a straight incision on the inner surface of the foot, beginning one-half of an inch above the joint, and carrying it downward to the middle of the first phalanx. From the termination of this incision, a slightly curved incision is made on the dorsal surface to the commissure of the toes, and then one is made in a similar way on the plantar surface, joining the one first made. These flaps are dissected up to the joint,

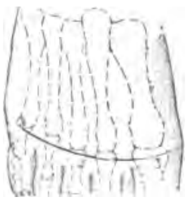
Amputation of the Littl
method.

Operation.—This toe can be re in the same manner as those emplo tion of the great toe.

Amputation of all of the
method.

Operation.—Fix the positions (332), and make a semilunar incisi front of them, carrying it from one 335). A short flap is then dissectec and opened by dividing the extens

Fig. 335.



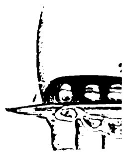


Fig. 337.

Fig. 338.

tendons retrenched, and the plantar flap is drawn up over the ends of the metatarsal bones, and secured by suture to the dorsal flap. Fig. 338 shows the stump after this operation.

Amputation in the Continuity of the Metatarsal Bones.—*By the Flap method.*

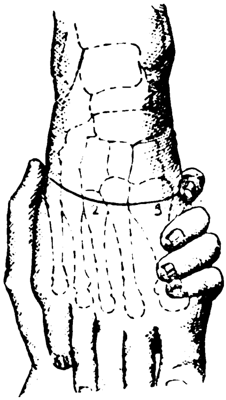
Operation.—Amputation through the metatarsal bones is performed by making a semilunar incision on the dorsum of the foot, a short distance below the point of section of the bones, dividing all of the tissues to the bones. Dissect up the integuments to a slight extent, and form a plantar flap by transfixion, introducing the knife, carrying it, in close contact with the bones, to the commissure of the toes. The flaps are retracted by a six-tailed retractor, four of the tails being passed through the four interosseous spaces, and the bones divided by the metacarpal saw. The vessels are ligatured, the tendons on the dorsal and plantar surfaces retrenched, and the plantar flap placed over the divided ends of the bones and secured to the dorsal flap by sutures.

articulating in order with the fi
tarsal bones, cuboid articulating
tarsal bones.

Ligaments.—The ligaments :
interrosseous.

Line of the articulation.—A
behind the tuberosity of the fifth

Fig. 339.



incision, dividing the skin and fasciæ, should be made, with a strong scalpel, over the dorsum of the foot between the points above given, passing a short distance below the line of the articulation (Fig. 339). The skin and fasciæ should be dissected up to a slight extent, and another incision, across the foot, on a level with the edge of the retracted skin, should be made, dividing the remaining structures down to the bones. The dorsal ligaments should now be divided from the fifth to the second metatarsal bone, then the dorsal ligament connecting the first metatarsal bone to the internal cuneiform, and lastly, the dorsal ligament between the second metatarsal bone and the middle cuneiform, bearing in mind that the line of the articulation between the second cuneiform bone and the second metatarsal bone is one-third of an inch above the others (Fig. 340). The knife, being held at an angle of 45° to the axis of the foot,

Fig. 341.

with the edge turned upward, should now be introduced between the first and second metatarsal bones, and carried up to a right angle, dividing with its point by this movement

the ligament which binds the head of the second metatarsal bone to the outer surface of the first cuneiform bone (Fig. 341.) Complete division being effected by giving the knife a rocking motion, it is withdrawn and applied in the same

Fig. 342.

Fig. 343.

manner between the second and third metatarsal bones, and the head of the second metatarsal bone separated from the inner surface of the third cuneiform bone. Depressing the foot firmly, the joint is opened and the remaining attachments can be divided. The plantar ligaments and the tendons of the peronei muscles should now be divided. An amputating knife is then introduced beneath the heads of the metatarsal bones (Fig. 342), and a flap made from the sole of the foot by carrying the knife forward

Fig. 344.

in close contact with the surfaces of the bones, care being taken to avoid the sesamoid bones of the great toe. The flap should be terminated at the roots of the toes by a broadly convex border (Fig. 343).

The dorsalis pedis in the upper, and the two plantar arteries in the lower flap are divided, and may require the application of a ligature. The tendons being retrenched, the plantar flap is brought up over the exposed surfaces of the bones of the tarsus, and united to the upper flap by sutures. In Fig. 344 the stump after amputation by this method is shown.

Amputation at the Tarso-metatarsal Articulation.—(Hey's operation.)

This operation is a modification of that just described, and differs from it in the method of forming the flaps and in the section of the internal cuneiform bone.

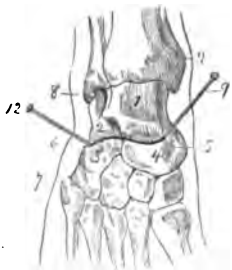
OPERATION.—A transverse incision, dividing the structures to the bone, is made across the foot, extending from the tuberosity of the fifth metatarsal bone to a point midway between the head of the first metatarsal bone and the tuberosity of the scaphoid. From the extremities of this incision, lateral incisions are made to the toes, and are connected by an incision across the sole of the foot, [illegible] the toes. A flap from the sole of the foot is dissected back to the articulation, and disarticulation of the second, third, fourth, and fifth metatarsal bones effected by dividing the dorsal, plantar, and interosseous ligaments. The operation is now completed by dividing with the saw the projecting portion of the internal [illegible]. The remaining steps of the operation are performed [illegible] manner as described in Lisfranc's operation.

Amputation at the Medio

—*By the flap method* (Chopart's o

Bones.—The bones entering i
articulation, on the inside, are th
the scaphoid in front; outside, os
cuboid in front (Fig. 345).

Fig. 345.



1. Astragalus.
2. Os calcis.
3. Cuboid.
4. Scaphoid.

behind the head of the fifth metatarsal bone to a point one inch in front of the internal malleolus, or immediately behind the tubercle on the scaphoid bone. This line will be three-quarters of an inch in front of the ankle-joint.

OPERATION.—Grasping the foot with the left hand so that the thumb and index finger shall rest at the points given on the inner and outer side of the foot, indicating the position of the articulation, the knife, a strong scalpel, should be carried across the dorsum of the foot, making a short, slightly convex flap (Fig. 346). Dissecting up the integuments to a slight extent, a second incision should be made on a level with the retracted flap, dividing the remaining structures down to the bones. Fixing the line of the articulation, the dorsal and interosseous ligaments are divided, exposing the joint fully. Dividing the plantar

Fig. 347.

Fig. 348.

ligaments, an amputating knife is placed beneath the bones (Fig. 347), and a flap of sufficient length made from the sole of the foot (Fig. 348). The arteries which are divided

in this operation are the dorsalis pedis in the dorsal flap, and the plantar arteries in the plantar flap. The tendons are retrenched, and the plantar is attached to the dorsal flap by means of sutures.

In this operation attention is directed to the importance of making the lateral incisions low down upon either side, so as to pass the knife readily under the bones, and of giving an oval shape to the border of the plantar flap. In seeking the line of the articulation, it is desirable to avoid getting too far back, so as to reach the line between the astragalus and os calcis, and equally desirable to avoid advancing so far forward as to get between the scaphoid and cuneiform bones. The convex and rounded articulating surface of the astragalus is to be distinguished from the articulating surface of the scaphoid, which shows three distinct impressions, which receive the articulating surfaces of the three cuneiform bones. The stump after union has occurred is shown in Fig. 349.

Fig. 349.

By the flap method. (Tripier's operation.)—Commencing at the outer edge of the tendo Achillis, on a level with the external malleolus, an incision through the integument is to be made in a direction at first downward and forward, and afterwards forward, passing two fingers' breadth below the malleolus, and then approaching by a finger's breadth the upper part of the base of the fifth metatarsal bone (Fig. 350). From this point the incision is to be carried upward, forward, and inward, so as to reach the inner margin of the tendon of the extensor proprius pollicis, just behind the first

tarso-metatarsal articulation. The knife should now be made to cut downward and forward, so as to enter the sole of the foot a finger's breadth in front of the dorsal incision. The incision is then to be carried with a gentle forward curve, outward and backward, until it can be made continuous with the first portion of that below the outer malleolus (Fig. 351). The divided integument having undergone some degree of

Fig. 350.

Fig. 351.

retraction the dorsal and plantar structures are to be divided half an inch behind the superficial incision; the soft parts are then to be separated from the bones, extreme care being taken to preserve uninjured the vessels contained on the inner part of the plantar flap. At this stage, the cuboid and scaphoid should be disarticulated from the os calcis and astragalus, the periosteum then divided and separated from the under surface and posterior extremity of the os calcis up to the level of the sustentaculum tali where the bone is to be sawn through in a direction from behind and within,

53

forward and outward, so as to leave a surface which will be at right angles with the axis of the tibia when the limb assumes the position for walking or standing (Fig. 352).

Fig. 352.

Fig. 353.

All sharp bone edges and angles should be rounded off. The posterior tibial nerve is to be retrenched to avoid danger of neuroma, and the wound dressed so as to secure moderate flexion of the ankle-joint during repair (Fig. 353).

Amputation at the Tibio-tarsal Articulation.—*By the flap method* (Syme's operation).

Bones.—The bones entering into the formation of the articulation are the lower extremity of the tibia on the inside, terminating in the internal malleolus, and the lower extremity of the fibula on the outside, terminating in the external malleolus, embracing the broad trochlear surface of the astragalus, and forming a true ginglymoid joint free from lateral motion.

Ligaments.—The ligaments of the articulation are the anterior, the internal lateral or deltoid, and the external lateral, consisting of three fasciculi. The transverse liga-

ment of the tibia and fibula supply the place of a posterior ligament to the joint.

Lines of incision.—First.—From the centre of the outer malleolus, downward and across the sole of the heel, in a straight line; then upward to a point on the same level of the opposite side, a slight distance below and behind the extremity of the inner malleolus (Figs. 354, 355).

Second.—An incision across the instep, connecting the points of the first incision.

OPERATION.—The leg being supported, and the foot placed at right angles to the leg, an incision should be made with the scalpel from the outer malleolus to a point on the same level of the opposite side, a slight distance below and behind the extremity of the inner malleolus, across the heel, dividing the structures to the bone, in the line indicated. The anterior incision across the instep should be next made, and the posterior flap dissected from the surface of the os calcis, the knife being kept in close con-

Fig. 354.

Fig. 355.

contact with the bone, so as to avoid wounding the blood-vessels and transfixing the flap (Fig. 356.) This can be accomplished by placing the fingers of the left hand upon the heel, the thumb resting upon the edge of the integument, and keeping the knife between the thumb-nail and the sur-

Fig. 356.

face of the bone, at the same time pressing back the tissues as they are detached. The tendo Achillis, when exposed, should be divided, and disarticulation effected by cutting into the joint on the dorsum, and the sides of the foot at the margin of the anterior flap. The tissues are dissected upward so as to expose the malleoli fully, the knife carried around so as to divide the periosteum, and the saw applied, removing a thin slice of the tibia with the two malleoli.

The arteries divided in this operation and requiring ligature are the dorsalis pedis on the dorsal surface, and the two plantar. The tendons having been retrenched, the posterior

is to be placed in apposition with the anterior flap and secured by sutures, and an opening made in the posterior flap to secure drainage.

Fig. 357.

In performing this operation, the surgeon should bear in mind the importance of keeping the knife close to the bone in dissecting off the posterior flap, in order to avoid wounding the vessels which nourish the tissues, and also to avoid puncturing the flap, which, where it is in contact with the tendo Achillis, is very thin and closely adherent. The character of stump formed after this operation is shown in Fig. 357.

Amputation at the Tibio-tarsal Articulation (Pirogoff's operation).

This operation is a modification of Syme's method, and consists in leaving the posterior portion of the os calcis in the heel flap, and placing it in apposition with the surfaces of the tibia and fibula, the articulating surfaces of which have been removed.

OPERATION.—The incisions, in this operation, are made in the same manner as in Syme's operation, the lines of section through the integument (*b*) and the bones (*a*, *c*) being shown in Fig. 358. The articulation is opened from the front, and the lateral ligaments divided, thus disarticulating the head of the astragalus. A small narrow-bladed saw, or a saw such as is used in excisions, is placed obliquely upon the os calcis behind the astragalus, exactly upon the lesser process of the bone, or sustentaculum tali, and section of the

bone is made following the line indicated (*a*) in Fig. 358. The malleoli are next exposed and removed by the saw, the

Fig. 358.

tendons are retrenched, and the posterior flap containing the segment of the os calcis is now brought up and attached

Fig. 359.

to the anterior flap, placing the bony surfaces in apposition.

Fig. 360.

The direction given to the line of section of the os calcis in this operation is a matter of importance, in order that the bones may be brought accurately into apposition. Care should be taken to avoid making the section too oblique and also in beginning the section too near the astragalus. Fig. 360 represents the stump formed after this method of amputation.

Amputations of the Leg.—SURGICAL ANATOMY.—The leg is that portion of the lower extremity which extends from the thigh to the foot, and may be divided into the upper, middle, and lower third.

Bones.—The bones which enter into its formation are the Patella, the Tibia, and the Fibula.

The *Patella* is a large sesamoid bone placed in front of the knee-joint. Its purpose is to protect the front of the joint and to increase the leverage of the extensor quadriceps femoris muscle.

The *Tibia* is a large prismoidal-shaped bone placed on the inside of the leg, entering by an expanded upper extremity into the formation of the knee-joint, and below into the ankle-joint by its lower extremity, the internal malleolus. It presents on its anterior surface a sharp crest which lies subcutaneous in its entire extent.

The *Fibula* is a long slender bone occupying a position on the outside of the leg, articulating by its upper extremity with the tibia, and below terminating in the outer malleolus, which forms part of the ankle-joint.

Ligaments.—The tibia and fibula are united by the interosseous ligament, and are connected to the astragalus below by the ligaments already described (page 626).

Muscles.—On the inner side of the anterior surface the tibia is placed, its crest being subcutaneous. In the middle and on the outer or fibular side of this surface the tibialis anticus, extensor proprius pollicis, extensor longus digitorum, and peroneus tertius muscles are situated. Two layers of muscles occupy the posterior surface; the gastrocnemius, soleus, and plantaris muscles being superficial and forming the "calf." The deep layer consists of the popliteus, flexor longus pollicis, flexor longus digitorum, and tibialis posticus. On the fibular surface the peroneus longus and brevis are placed.

Bloodvessels.—The anterior and posterior tibial and the peroneal arteries pass down on the anterior and posterior surface of the leg, the anterior tibial lying on the anterior surface of the interosseous ligament until it reaches the lower part of the leg, while the posterior tibial and peroneal arteries rest upon the posterior surface of the posterior tibial muscle.

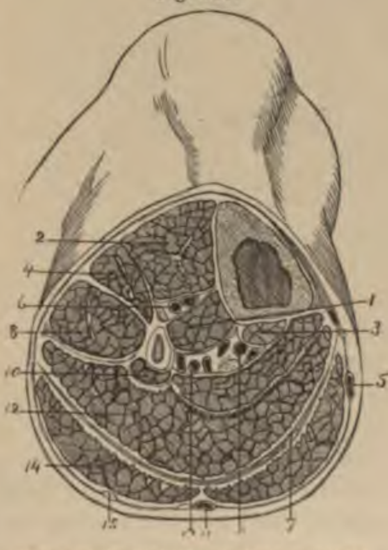
Nerves.—The anterior tibial and musculo-cutaneous nerves are distributed to the anterior surface of the leg, while the posterior tibial and peroneal supply the posterior and outer surface (Fig. 361).

Amputation may be performed in either the lower, middle, or upper third of the leg, and by the circular, oval, rectangular, single or double flap methods. The circular and rectangular methods are best adapted for the lower third, the modified circular or flap methods are preferable in the middle and upper third. Amputation of the leg should never be performed above the tubercle of the tibai

or the points of insertion of the biceps, semi-tendinosus, and semi-membranosus muscles, which are necessary in controlling the movements of the stump. The point of election, or the most desirable point for removal of the leg, is from two to two and a half inches below the tuberosity of the tibia.

Fig. 361.

1. Tibialis posticus muscle.
2. Tibialis anticus muscle.
3. Flexor longus digitorum.
4. Extensor longus digitorum.
5. Internal saphenous vein.
6. Anterior tibial vessels and nerve.
7. Tendon of the plantaris muscle.
8. Peroneous longus muscle.
9. Posterior tibial vessels and nerves.
10. Flexor longus pollicis.
11. External saphenous vein and nerve.
12. Soleus muscle with fibrous intersection.
13. Peroneal vessels.
14. Gastrocnemius muscle.
15. Communicans peronei nerve.



Section of the Right Leg in the upper third, showing structure.

Operation.—*In the lower third.*—Three to three and one-half inches above the ankle-joint.

By the circular method.—The limb being supported by an assistant, the proximal part is grasped by the left hand of the operator, the skin firmly retracted, and the amputating knife is carried around the limb, making a circular

incision (Fig. 362, *a*), dividing the skin and superfici
fascia in the manner already described (page 581). Th
cuff of skin an
fascia is dissecte
up to the extent
one and one-half t
two inches and turn
ed back. Guard
ing carefully th
margin of the re
tracted cuff, a cir
cular incision i
made around the
limb at this point,
dividing the mus
cles and other struc
tures to the bones
These, with the pe
riosteum, are dis
sected back to the
extent of an inch

Fig. 362.

or more, and the interosseous membrane divided with the
catlin or a large scalpel. A three-tailed retractor is now
applied, the middle tail being passed through the inter
osseous space from below upward and the tissues firmly re
tracted. The saw, held in a vertical position, should be
applied to both bones, drawing it from heel to point and
dividing them by short, even strokes, care being taken tha
the fibula, which is the smaller and most movable bone
should be divided first.

The anterior and posterior tibial and peroneal arteries
are divided and require ligature. The anterior tibial artery

at this point lies in front of the tibia. The posterior tibial and peroneal arteries should be sought for in the interspace between the soleus muscle behind, and the tibialis posticus muscle in front, the former lying somewhat behind the tibia, and the latter along the inner border of the fibula. The vessels having been ligatured, the tendons and nerves retrenched, the cuff is drawn down and the edges approximated by sutures in the transverse or vertical direction.

In amputations of the leg it is desirable to remove the sharp point formed by the crest of the tibia after section. This should be done with the saw or bone pliers, cutting obliquely from above downward.

In the lower third. By the rectangular method (Teale's operation).

Operation.—The lines of incision having been traced out on the limb, the knife is introdced on one side at the point of intended section of the bones and carried downward to a distance equal in length to one-half or one-third the circumference of the limb, dividing all of the structures to the bone (Fig. 326). A similar incision is made on the opposite side, and the two are united by one made transversely across the anterior surface of the leg. The flap, containing the skin and muscular structures, is now dissected up, care being taken to avoid wounding the anterior tibial artery at the base of the flap. The posterior flap, equal in length to one-eighth the circumference of the limb, or one-fourth the length of the anterior flap, is made by a circular incision down to the bone. This flap is dissected up to the requisite extent, the interosseous membrane is divided, the retractor applied, and the bones sawn (Fig. 327). The vessels having been ligatured, the tendons and nerves re-

trenched, the long flap is turned over the ends of the bones and attached to the short flap by sutures (Fig. 328).

In the middle and upper third. By the double-flap method.—Antero-posterior.

OPERATION.—The limb being supported, the operator grasps the proximal part (placing the thumb and index finger at the points on the outer and inner surfaces of the leg, so as to indicate the breadth of the flap, as well as the point of section of the bone), retracts the skin, and makes a semilunar incision, either with the scalpel or small amputating knife, across the front of the leg from the inner edge of the tibia to the outer edge of the fibula, dividing skin and superficial fascia. This flap, which should be one-fourth the length of the posterior and cutaneous in character, is dissected up to the requisite extent, and, the leg being flexed slightly, the amputating knife is entered at the external angle of the first incision and made to transfix the structures on the posterior part of the leg, emerging at a point corresponding on the opposite side of the leg (Fig. 363). In

Fig. 363.

passing the knife, care should be taken to avoid carrying its point *between* the bones. This is likely to occur, unless the operator bears in mind that the edge of the fibula is on a plane posterior to that of the tibia, and, therefore, the handle of the knife should be *elevated* in order to *depress* the point as it passes behind the bone. The knife, having

transfixed the tissues, is carried downward in close contact with the surface of the bones, forming a flap of at least four inches in length. The flaps are now drawn back, the remaining structures and interosseous membrane divided, the retractor applied, and the bones sawn.

The anterior and posterior tibial and peroneal arteries will require ligature—possibly some of the larger muscular branches. Sometimes difficulty is experienced in surrounding the anterior tibial artery with a ligature, owing to its retraction above the section of the interosseous membrane upon which it lies. Extension of the limb will frequently cause it to project, so that it can be seized and ligatured.

The vessels having been ligatured, and the tendons and nerves retrenched, the flaps are approximated by sutures.

By the lateral double-flap method.—Long external and short internal flap (Sédillot's operation).

OPERATION.—The limb being flexed and the foot extended, the skin is elevated over the point of intended section, and the amputating knife is introduced midway between the crest of the tibia and the fibula, and, passing external to the latter, is brought out in the calf of the leg (Fig. 362, *c*). Carrying it downward in close contact with the external surface of the bone, a long external flap is formed. A transverse incision, slightly convex forward, divides the tissues on the inside of the leg. Dissecting up this flap to the requisite extent, the interosseous membrane is divided, the retractor applied, and the bones sawn as described in the other operations.

Amputation at the Knee-joint.—SURGICAL ANATOMY.—The knee is a ginglymoid or hinge-joint, composed

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of three bones, the condyles of the femur above, the patella in front, and the upper extremity of the tibia below. The bones are united by fourteen ligaments, anterior, lateral, posterior, and internal, the more important of which are—

The *anterior* or *ligamentum patellæ*, a portion of the tendon of the extensor quadriceps femoris, measuring three inches in length, and extending from the lower border of the patella to the point of insertion in the tuberosity of the tibia.

The *lateral* ligaments are the internal, and the long and short external.

The *posterior*, or the *ligamentum posticum Winslowii*, covers over the entire posterior portion of the joint, and is formed of dense fibrous tissue.

Of the ligaments within the joint, the two *crucial*, anterior and posterior, and the two *semilunar fibro-cartilages*, the internal and external, are the most important in the surgical point of view.

The crucial ligaments are strong interosseous bands attached, below, to the spine of the tibia, and, above, to the outer and inner condyles of the femur, crossing each other as they pass from below upward, the anterior being attached to the front of the spine of the tibia and the inner surface of the outer condyle, and the posterior to the back of the spine and the outer surface of the inner condyle.

The semilunar fibro-cartilages are two crescentic lamellæ attached to the borders of the head of the tibia, and serve to deepen the surface for articulation with the condyles of the femur.

The tendons of the powerful muscles of the thigh, with some of the muscles of the leg, surround and protect it,

while important bloodvessels and nerves have intimate relations with the joint (Fig. 364).

The condyles of the femur are two large eminences, into which the lower extremity divides. The external condyle is the more prominent anteriorly, and broader, while the internal is most prominent internally, and narrower. It is to be remembered that they are not on the same level, the internal being nearly one-half of an inch lower than the external. The tuberosity on the outer surface of the external condyle is less prominent than that on the internal. The line of the articulation may be described as extending internally from a point three-quarters of an inch above the tuberosity of the tibia, across the lower border of the patella, and terminating externally three-quarters of an inch below the prominence of the condyle of the femur.

Fig. 364.

Vertical Section of the Knee-joint.
1. The femur.
2. The tibia.
3. The patella.
4. The crucial ligaments.

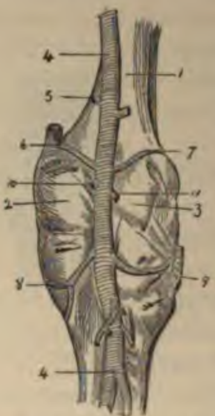
Amputation through the knee-joint may be performed by either the flap, circular, or oval methods. Of the flap methods, that by the long anterior and short posterior is preferred.

Amputation by the long anterior and short posterior flap methòd, retaining the Patella.

Operation.—The knee being flexed, an incision is made, with the scalpel or small amputating knife, from a point on a line with the condyle, near to the border of the popliteal space, across the front of the leg, two and one-half inches below the tubercle of the tibia, to a point corresponding on

the opposite side. Dissecting up this flap, the ligamentum patellæ and the lateral ligaments are divided, opening the joint. The crucial ligaments are next divided, and any remaining portions of the lateral ligaments, thus completely exposing the joint. The amputating knife is now placed behind the head of the tibia, and a short posterior flap is made by cutting downward, keeping the knife in close contact with the bone, care being taken to avoid the head of the fibula. The popliteal artery will require ligature, and possibly several of its branches (Fig. 365). It lies in close contact with the posterior surface of the posterior ligament of the joint, and should be sought for in this position. The tendons and nerves are retrenched, and the anterior flap drawn down over the condyles of the femur, and attached to the posterior by sutures.

Fig. 365.



The Popliteal Artery and its Branches in relation with the Knee-joint.

1. Femur.
2, 3. Condyles of femur.
4. Popliteal artery.
5, 6, 7. Superior articular braches.
8, 9. Inferior articular branches.
10, 11. Sural branches.

The importance of keeping near to the margins of the popliteal space is to be borne in mind, in order that a flap of sufficient size may be secured to cover the large articulating surfaces of the condyles of the femur.

By the short anterior and long posterior flap.—This method of amputation may also be employed, in which case the patella is removed, and also the condyles of the femur, the long flap being taken from the muscles forming the calf of the leg (Figs. 366, 367).

Fig. 366.

Short Anterior and Long Posterior Flap.
1, 2, 3. Line of incision for anterior flap.

Fig. 367.

Short Anterior and Long Posterior Flap.
1, 2, 3. Line of incision for posterior flap.

By the circular method.—The circular method may be employed in affecting disarticulation, the first incision being carried around the limb, through the integument, three or four fingers' breadths below the patella. This flap is dissected up to the line of the articulation, and disarticulation effected by division of the ligamentum patellæ, the lateral ligaments, the crucial and, finally, the posterior ligament (Fig. 368). The edges of the flaps are united in either the transverse or vertical direction.

By the oval method (Bauden's method).—This operation is described as follows—The knife is entered three fingers' breadths below the tuberosity of the tibia, cutting at first transversely, then obliquely upward and around the limb to a point in the popliteal space two fingers' breadths below the line of the joint; the incision passes transversely across the back of the limb, and is continued obliquely downward

Fig. 368.

Circular Method.
1, 2, 3. Section of integuments.
4, 5. Reflected integuments.

Fig. 369.

The Oval Method.
1, 2, 3. Oblique section of the integuments.
4, 5. Reflected integuments.

to its point of commencement. This oval flap is dissected up, and disarticulation effected by dividing the ligaments of the joint (Fig. 369). The vessels are ligatured, and the edges of the flap approximated by sutures.

Amputation of the Thigh.—Surgical Anatomy.—The thigh is that part of the lower extremity which

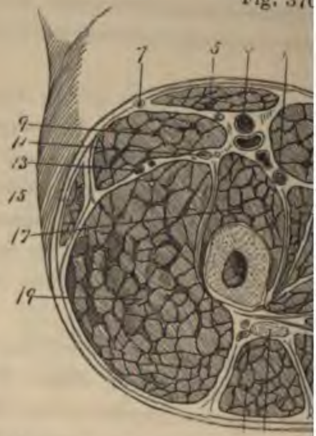
extends from the pelvis to the leg, and may be divided for the purposes of amputation into the upper, middle, and lower thirds. It is larger above than below, and has the shape of an inverted and truncated cone. It is composed of one large bone, numerous large and powerful muscles, bloodvessels, nerves, and lymphatics, and is covered by the integument, superficial fascia, and a strong aponeurosis (fascia lata).

Bone.—The bone of the thigh, the femur, is the largest, longest, and strongest bone in the skeleton. The superior extremity is divided into a globular head which enters into the formation of the hip-joint, a neck varying in length and obliquity, and two prominent processes, the trochanters—the greater on the outside and the lesser on the inside. The inferior extremity terminates in the condyles which form part of the knee-joint.

Muscles.—Large and powerful muscles occupy the anterior, internal, and posterior surfaces of the thigh; on the anterior surface the tensor vaginæ femoris, sartorius and quadriceps extensor femoris, and subcrureus; on the internal surface the gracilis, pectineus and adductors longus, brevis, and magnus; on the posterior surface the biceps, semitendinosus, and semimembranosus. Attached to the inner trochanter is the common tendon of the psoas magnus and iliacus, while to the outer trochanter and upper part of the shaft are the glutei, the pyriformis, the two obturators, the two gemelli, and quadratus femoris.

Bloodvessels.—The femoral artery, and branches of the internal iliac, supply the structures of the thigh; the former in its course down the thigh passes from the anterior to the inner, and then to the posterior surface; the latter escape from the pelvic cavity through the great sciatic fora-

Fig. 37(



Section of the Right Thigh at the ape
showing structu

1. Profunda femoris vessels.
2. Adductor longus muscle.
3. Femoral vessels.
4. Superficial obturator nerve.
5. Sartorius muscle.
6. Gracilis muscle.
7. External cutaneous nerve.

13. Ex
14. Ad
15. Te
16. Sem
17. Vas
m
18. Sem

Amputation may be performed at any point of the limb, and by either the circular, oval, flap, or rectangular method. The flap method is that which is usually preferred, owing to the ease with which it is performed and the complete covering it gives to the end of the bone. In performing amputation by the flap method the tendency to powerful retraction on the part of the muscles of the thigh should be remembered, and the flaps made ample in order to avoid the formation of a conical stump.

Amputation through the base of the condyles. By the single anterior flap method (Carden's method).

OPERATION.—The anterior flap is made by carrying an incision from a point two inches above the tuberosity on the outer condyle of the femur, downward, forward, and inward across the anterior surface of the knee-joint, below the tubercle of the tibia, to a similar point above the tuberosity on the inner condyle. The flap is dissected up from the patella, and the angles of the first incision are joined by a circular incision across the posterior surface carried to the bone. The flaps are retracted and the condyles removed through the base. The vessels are ligatured, the nerves retrenched, and the anterior flap is drawn over the bone and attached by sutures to the posterior incision (Fig. 371).

Through the base of the condyles. By the long anterior and short posterior flap method (Gritti's method).

OPERATION.—In the operation performed by this method the anterior flap is made by carrying an incision, from a point two inches above one condyle, across the knee, just below the tuberosity of the tibia to a corresponding point on the opposite side (Fig. 372). The flap, formed of the integument and fascia, is dissected up, the ligamentum patellæ divided and a thin section is removed by the saw from the

Fig. 371.

off through the base. The vessels a
retrenched, and the flaps are approx
of the patella and femur being place

In the lower third. By the anter

OPERATION.—The tissues on the
thigh being grasped firmly

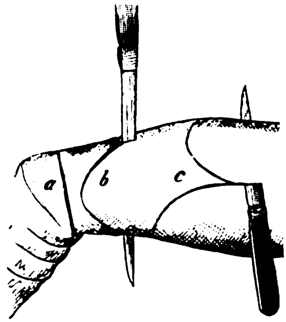
the distance of two to three inches as may be necessary, when its edge is turned and is made to cut its way out in an oblique direction. The knife is re-entered at the original point, carried behind the bone, emerging at the same point as before, and the posterior flap, which should be somewhat longer than the anterior, is formed by cutting downward and then outward as in forming the first flap; a circular sweep is now made around the bone, dividing the remaining tissues, with the periosteum; the latter is dissected up to a short extent, the retractor applied, and the bone sawn through. The arteries divided and requiring ligature are the femoral and some of its muscular branches. The artery is found on the inside under the sartorius, with the vein to the outside.

The flaps are retrenched, if necessary, and united by sutures.

In the lower third. By lateral flaps.

Operation.—The tissues on the side of the limb being grasped so as to elevate and retract them, the knife is entered in the vertical direction, carried down to the bone, passing to one side, and emerging on the posterior surface of the thigh at a point exactly opposite that of entrance. It is then carried downward in close contact with the bone, and then outward, forming a flap from three to four inches in length as may be required. The knife is reintroduced at the same point, passed around the bone, and is brought out at the same point on the posterior surface of the limb, and a flap formed as before (Fig. 373, *b*). A circular sweep is made, dividing the remaining structures with the periosteum, the latter is dissected up to a slight extent, the retractor applied, and the bone sawn through. The vessels

Fig. 373.



Operation.—Amputation by thi
by making a flap from the anterior s
and breadth at its free extremity to
cumference of the limb at the point
This flap is made by transfixion, and
artery. A slightly convex incision,
the bone, is made on the posterior s
the base of the long flap. The opera
other methods

third to one-half the circumference of the limb. These incisions are joined at their lower extremities by a transverse incision, and the flap, including all of the structures to the bone, is to be dissected up. The short or posterior flap, containing the vessels and equal in length to one-fourth of the long flap, is made by a transverse incision to the bone. This flap is dissected up, and, the retractor having been applied, the bone is sawn through (Fig. 327). The vessels are ligatured, and the sutures introduced, uniting the flaps (Fig. 375).

Fig. 374.

Fig. 375.

In the lower third. By the circular method.

OPERATION.—Amputation by this method is performed by making a circular sweep around the limb just above the upper margin of the patella (Fig. 373, *a*), dividing the skin and superficial fascia. Firm traction is made by an

deeper muscles divided, by a circul
The retractor is applied, the bone sa
and the operation completed by app
sutures.

This method of performing the ci
complete covering to the end of the
apex of a hollow cone, the base bein
of the integuments.

Fig. 376.

of the bone, and an incision of the muscles made as in the circular operation just described. The semilunar flaps covering the muscles are united by sutures, as in the flap method.

In the middle third.—Amputation at this point may be performed by any of the methods employed in the lower third. The retraction of the muscles being here less than in the lower third, the flap method can be adopted with advantage (Fig. 373, *c*).

In the upper third, below the trochanters.—At this point amputation by the antero-posterior flap is deemed the most desirable method, and is performed in the same manner as in the middle or lower third.

Amputation at the Hip-joint.—SURGICAL ANATOMY.—The hip-joint is an enarthrodial or ball-and-socket joint formed by the reception of the globular head of the femur into the cup-shaped cavity of the acetabulum, placed on the outside of the os innominatum.

Bones.—The bones which enter into the formation of the joint are the femur and the os innominatum, consisting of the ilium, ischium, and pubes.

Ligaments.—The principal ligaments of the joint are the *capsular*—ilio-femoral and teres; the *cotyloid* is a fibro-cartilaginous rim which serves to deepen the cavity of the acetabulum, and the *transverse* is placed across the acetabular notch, converting it into a foramen. The *capsular* is a strong, dense ligament which envelops the joint, being attached above to the margin of the acetabulum, and below, around the base of the neck of the femur. The *ilio-femoral* is a re-enforcing or an accessory ligament extending obliquely across the front of the joint. The *teres* ligament

consists of a triangular band of fibres, the apex of which is inserted in a depression placed on the head of the femur *a little behind and below its centre;* the base is attached to the margins of the notch on the floor of the acetabulum.

Muscles.—The joint is surrounded on all sides by large, strong muscles which cover and protect it. They take their origin in general from the different parts of the pelvis adjacent to the articulation, and are attached to the trochanters and upper portions of the shaft of the femur. They have been named in connection with the muscles of the thigh.

Bloodvessels.—The bloodvessels which supply the joint are derived from the obturator, sciatic, internal circumflex, and gluteal arteries. The femoral artery passes in front of the articulation, separated by the capsular ligament and the inner margin of the psoas magnus muscle, upon which it rests.

Nerves.—Branches from the sacral plexus, the great sciatic, obturator, and accessory obturator supply the joint (Fig. 377).

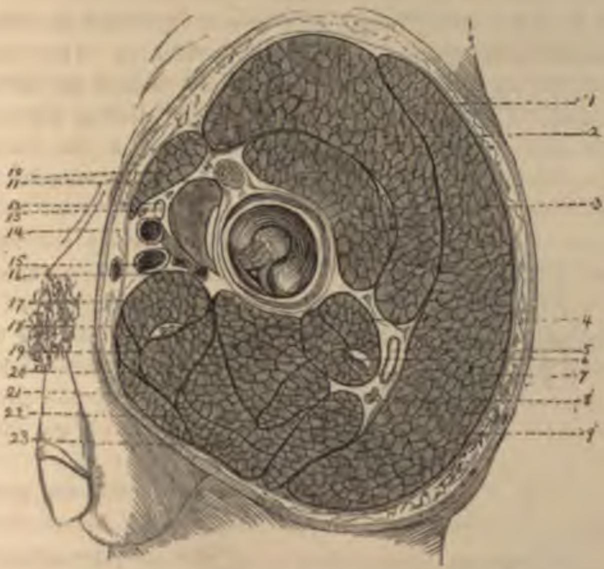
The articulation being placed deeply beneath the muscular and other structures, and therefore difficult to reach by manipulation, it is important to establish the positions and relations of certain fixed points. Bernard and Huette give the following guides to the articulation, which should be borne in mind in operations upon the joint.

1. The anterior inferior spinous process of the ilium is three-quarters of an inch above the superior margin of the acetabulum; the anterior superior spinous process is about an inch and three-quarters above the same point, and three-quarters of an inch to its outer side.

2. The subject being erect, a line drawn from the anterior superior spinous process of the ilium to the tuberosity

of the ischium, crosses the acetabulum at the junction of its posterior with its anterior two-thirds.

Fig. 377.



Section through the Hip-joint and Gluteal region.

1. Gluteus maximus muscle.
2. Gluteus medius muscle.
3. Gluteus minimus muscle.
4. Pyriformis muscle.
5. Great sciatic nerve and vessels.
6. Tendon of obturator internus muscle.
7. Gemelli muscles.
8. Biceps muscle.
9. Quadratus femoris muscle.
10. Sartorius muscle.
11. Reflected tendon of the rectus muscle.
12. Psoas and iliacus muscles, with bursa.
13. Anterior crural nerve.
14. Common femoral artery.
15. Common femoral vein.
16. Profunda artery.
17. Gracilis muscle.
18. Semimembranosus muscle.
19. Adductor brevis muscle.
20. Semitendinosus muscle.
21. Obturator externus muscle.
22. Adductor longus muscle.
23. Adductor magnus muscle.

3. The anterior border of the acetabulum is from an inch to an inch and a quarter to the outer side of the spine of the pubes.

4. The axis of the horizontal ramus of the pubes, extended by an imaginary line, crosses the acetabulum at the junction of its superior with its middle third.

5. The superior border of the trochanter major is on a level with the upper third of the cavity of the joint (Fig. 378).

Fig. 378.

As the capsular ligament is attached around the borders of the acetabulum, it is desirable, in order to divide the ligament readily and open the joint, to carry the knife around the margin of this cavity. In doing this, it should be remembered that the acetabulum projects further over the head of the femur posteriorly than it does anteriorly, and the knife, therefore, when applied posteriorly, should be carried obliquely from behind forward and inward.

Amputation at the hip-joint may be performed by the flap method, single or double, antero-posterior or lateral, the oval, and the circular methods.

By the single anterior flap.—The patient being placed upon the table, with the hip projecting, the limb flexed on the pelvis, and separated from its fellow, the operator takes a position on the outside of the limb, raises the soft structures on the anterior surface with his left hand, and enters the point of a long amputating knife midway between the anterior superior spinous process of the ilium and the great trochanter, and carries it to the articulation. Elevating the handle slightly, the point is carried over the articulation, transfixing the capsule as it passes, and is brought out at a point one inch below and in front of the tuberosity of the ischium, care being taken to avoid wounding the scrotum, which should be held out of the way by an assistant (Fig. 379). The knife, kept in close contact with the bone, is carried downward, forming a flap six inches long, both sides being of equal length. The flap is now raised, and the artery, which it contains, compressed by an assistant. With a large scalpel, the capsule of the joint is now divided on its anterior and inner surface, and the limb abducted and rotated outward by an assistant, so as to expose the insertion of the ligamentum teres into the head of the femur. This is divided, when the head of the bone can be luxated and the posterior portion of the capsular ligament divided. The heel of the ampu-

Fig. 379.

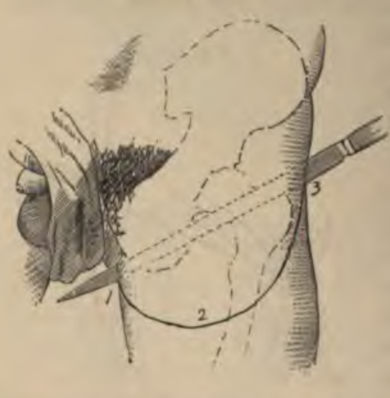
tating knife is now placed behind the trochanter major, the point projecting as before, and the structures forming the posterior portion of the thigh are divided in a vertical direction. If desirable, this last incision can be made from without inward by a circular sweep of the knife, as in the circular method.

The vessels which are divided, and require ligature, are the femoral, obturator, sciatic, external and internal circumflex.

The long anterior flap is drawn downward, and united to the posterior by sutures.

By the double-flap method.—Antero posterior.—In amputation by this method, the anterior flap is formed in the same manner as in the single anterior flap operation, the length being from three to four inches (Fig. 380). After the ligaments of the joint have been completely severed, the amputating knife is placed behind the great trochanter, and the posterior flap, of the same length as that of the anterior, is made from the tissues on the back of the thigh (Figs. 381, 382). The vessels are ligatured, and the flaps, having been retrenched, if necessary, are united by sutures.

Fig. 380.



By the double lateral flap method.—The patient being placed on the table, with the hip projecting beyond the edge,

Fig. 381.

Fig. 382.

a long amputating knife is entered at a point midway between the anterior superior spinous process of the ilium and the great trochanter, and pushed downward around the head of the femur on the outer side, and made to emerge immediately below the tuberosity of the ischium (Fig. 383). The tissues over the great trochanter are drawn outward, and the knife is carried downward and outward around the great trochanter, in close contact with the bone, forming a flap four inches in length. The knife is reintroduced at the lower angle of the wound, its point carried directly upward around the neck of the femur, and brought out at the upper angle. The tissues on the inside of the thigh are now drawn inward, and the knife is carried downward around the lesser trochanter, in close contact with the bone, forming a flap of the same length as that on the outside (Fig. 384). This

flap is raised, and the femoral artery grasped by an assistant. Disarticulation is effected by dividing the capsular ligament at the inner and upper part of the joint, next the ligamentum teres, the limb having been abducted and rotated outward in

Fig. 383.

Fig. 384.

order to expose its point of insertion into the head of the femur, and finally completing the disarticulation by dividing the remaining portion of the capsular ligament. The vessels are ligatured, the flaps placed in apposition, and united by sutures, as before described.

By the oval method.—The position of the femoral vessels having been definitely ascertained, the patient is placed upon the sound side and the point of the knife entered above the great trochanter and an oblique incision made backward, outward, and downward, to a point below the tuberosity of the ischium. The knife is re-entered at the upper angle of the wound and an incision carried forward, inward, and downward, terminating at a point just above the position of the femoral vessels. The muscles on the outer side,

which are attached to the great trochanter, are divided, exposing the capsule of the joint; this is divided externally, and the knife, being carried to the inner side, divides the ligamentum teres as the limb is rotated outward. Disarticulation is completed by cutting the remaining portion of the capsular ligament, and the knife, being placed behind the bone, divides the remaining structures by a transverse incision. The vessels are ligatured and the flaps approximated by sutures so as to form a linear incision.

By the circular method.—Amputation at the hip-joint by this method is performed by making a circular incision, dividing the skin and superficial fascia three to three and a half inches below the great trochanter. The skin flap is dissected up and a circular sweep of the knife is made, using great force and dividing the muscles to the joint. Disarticulation is effected, and the operation completed by ligaturing the vessels and approximating the flap in a direction slightly oblique.

By the modified circular method.—Double skin flaps and circular division of the muscles (Skey's operation).—In this method of amputation the knife is entered one inch below the anterior superior spinous process of the ilium and carried down in a vertical direction for an inch and a half; it is then carried inward, following nearly the line of Poupart's ligament and about four inches below it, and terminates by a gentle curve, at a point about two inches below the tuberosity of the ischium. The second incision begins at the end of the vertical incision and is carried on the outer side of the thigh, crossing the shaft of the femur immediately below the trochanter major and, passing circularly backward, terminates at the same point as the first incision. The flaps being dissected up to the highest extent, the muscles are divided by a circular sweep of the knife,

applied with great pressure. The joint being exposed, the ligaments are divided and disarticulation effected. The operation is completed by ligaturing the vessels and approximating the skin flaps.

By the linear and circular method.—(Furneaux Jordan's method).—Amputation at the hip-joint by this method is

Fig. 385.

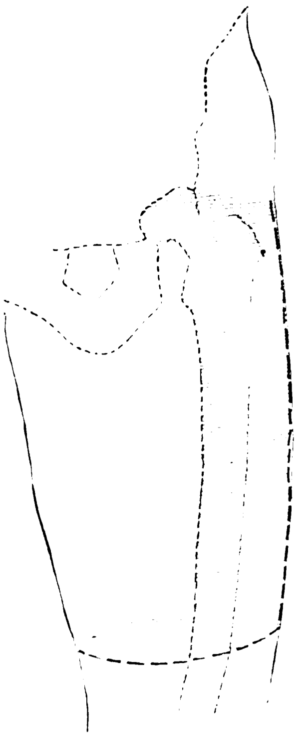
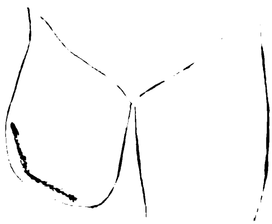


Fig. 386.

Fig. 387.



performed by making an incision on the outside of the limb eight inches long, beginning just above the trochanter major and carrying the knife to the bone. Enucleation and disarticulation of the bone is now effected by dissection, the knife being kept in close contact with the bone. At the lower extremity of the linear incision, a circular cut is made dividing the skin and superficial fascia. This flap is dissected up for an inch and retracted, and the muscles severed by a circular sweep of the knife carried to the bone (Fig. 385). The bone is now sawn, the vessels ligatured, nerves retrenched, and the edges of the wound approximated by sutures. Figs. 386 and 387 show the stump after this method of operation.

In amputations at the hip-joint or of the lower extremity the arterial circulation may be controlled by digital compression of the femoral artery immediately below Poupart's ligament. It may also be controlled in the middle third of the thigh by placing a compress over the artery beneath the tourniquet and applying the pressure so as to compress the vessel on the inner side of the shaft of the femur. Esmarch's bandage may be applied, carrying the turns to the hip-joint, and thus controlling the circulation in operations at any point of the extremity. The limb may be rendered largely free from blood by elevation continued for some time, and this condition may be main-

Fig. 388.

and remove them from pressure of
ment. The pressure of the pad m
fastening a roller to it. To obtain
to the best advantage the pad sho
abdomen immediately to the left o
aorta may also be compressed by th
the rectum or by the Davy's lever
manner.

THE UPPER EXTRE

Amputations of the Hand.—
—The hand is the terminal part of th
is divided into three portions—the
carpus or palm, and the phalanges or

Bones.—The *carpus* consists of ei
two rows; the first row contains th
cuneiform and pisiform; the second
trapezoid, os magnum, and unciform,
radial to the ulnar side.

The *metacarpus* is composed of fi
bones of the metatarsus, are classified

The *phalanges* are fourteen in

an arthrodial joint is formed; between the two rows an enarthrodial articulation exists. The carpus and the four inner metacarpal bones are connected by dorsal, palmar, and interosseous ligaments, while the articulation of the metacarpal bone of the thumb with the trapezium is enarthrodial in character, the two bones being united by a capsular ligament. The metacarpal bones are connected together by dorsal, palmar, and interosseous ligaments, and with the phalanges by anterior and two lateral ligaments.

The phalanges are united by anterior and two lateral ligaments. The articulations between the metacarpal bones and the phalanges, and between the phalanges, are true ginglymoid joints, and are lined by synovial membranes.

Muscles.—In addition to the tendons of the flexor muscles, which are inserted into the phalanges of the thumb and fingers, there are three groups of muscles placed on the palmar surface, and connected, respectively, with the thumb, little finger, and the palm.

On the dorsal surface the extensor tendons pass to their insertions into the bones of the thumb and fingers, while the interossei fill up the spaces between the metacarpal bones.

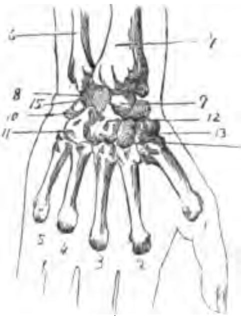
Articulations.—The articulations of the phalanges of the hand with each other, and with the metacarpal bones, present the regular lines which are observed in the phalanges of the foot. Between the metacarpal and carpal bones, the line of articulation is quite irregular, resembling in character, but in less marked degree, the irregularity of the line of articulation between the metatarsal and tarsal bones of the foot.

In the hand the second metacarpal bone is wedged in between the trapezium on the radial and the os magnum

carpal bone should be born

The line of articulation
bones is quite irregular, ov
of the scaphoid bone, pl
between the semilunar an
an inch above. From t

Fig. 389.



1–5. Metacarpal bones.
6. Ulna.
7 Radius.
8–15. Carpal bones.

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and ulnar nerves, while the

their distribution to the fingers. The radial and ulnar nerves, with their branches, are distributed to the posterior surface of the hand and fingers, following the course of the arteries.

In amputations of the hand, it is of the utmost importance that the operation should be performed in such manner as to save as much of the organ as possible. Every portion is of value to the patient, and can be made useful by him. Great care and discretion should therefore be exercised by the surgeon when called upon to perform amputations upon this part. A thumb and a little finger, or a thumb alone, or a little finger alone, if saved, will render better service than any artificial appliance which can be made.

Amputation of the Fingers.—*Methods.*—At the phalangeal articulations or in the continuity of the bones, amputation may be performed by either the *flap* or *circular* methods. At the metacarpo-phalangeal articulation, the *oval* method is best adapted.

Fig. 390.

1. Lower extremity of metacarpal bone.
2. First phalanx.
3. Head of first phalanx.
4. Second phalanx.
5. Third phalanx.

In performing amputation through the articulations of the fingers, it is important to establish the relations to the joint of certain fixed and constant surface markings which exist upon the palmar and dorsal surfaces. Upon the palmar surface three distinct transverse linear depressions are observed, which, with the finger in extension, have the following relation to the corresponding articu-

half beyond the articulation,

Fig. 391.

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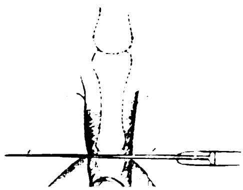
placed on the sides of the p
tremities. When the finger

Fig. 392.



is made to enter the joint by a transverse incision extending from one side to the other (Fig. 392); the lateral ligaments are now divided, completely opening the joint, and the blade of the bistoury is introduced behind the head of the bone (Fig. 393); keeping it in close contact with the bone, it is carried downward, forming a palmar flap of sufficient length (Fig. 394).

Fig. 393.

Fig. 394.

The digital arteries may require ligature. Retrenching the tendons, the palmar flap is brought upward over the end of the phalanx and attached by suture to the dorsal flap.

By the double flap method.—A semilunar incision is made across the dorsum of the finger, the points of origin and termination being over the articulation at the sides. The flap is dissected up, disarticulation effected, and a flap of equal length is made from the palmar surface of the finger by carrying the knife downward in close contact with the bone. The vessels are secured, the tendons retrenched, and the flaps united by suture.

By the circular method.—Amputation by this method may be performed by making a circular incision around the finger from one-quarter to one-half of an inch below the

line of the joint. The skin is retracted and disarticulation effected by division of the ligaments. The vessels are ligatured, tendons retrenched, and the skin flap is drawn over the head of the bone and the edges approximated in the transverse direction.

Amputation in the Continuity of the Phalanges.

OPERATION.—Amputation in the continuity of the phalanges may be performed by either the circular, flap, or rectangular flap method, the incisions being made in the same manner as at the articulations and the bone divided by the small saw or bone pliers.

Amputation at the Metacarpo-phalangeal Articulation.—Amputation at this articulation may be performed by either the oval, lateral flap, or circular method.

OPERATION.—*By the oval method.*—Fixing the position of the articulation, and flexing the finger at an angle of forty-five degrees, the incision is commenced one-quarter of an inch above the line of the joint on the dorsal surface and carried down to the commissure. Forcibly extending the finger, the incision is continued across its base in the fold of the skin, and thence upward to the point of origin. Dissecting up the skin and fascia, disarticulation is accomplished by dividing the extensor tendons

Fig. 395.

and lateral ligments, luxating the head of the phalanx and dividing finally the flexor tendons (Fig. 395). The arteries should be ligatured if necessary, the tendons retrenched, and the flaps united by sutures.

By the lateral flap method.—In this method the lateral flap is formed by carrying an incision from a point over the articulation obliquely downward to the side of the finger a short distance in front of the web, thence backward to a point on the under surface of the articulation. An incision of a similar character is made on the other side of the finger, uniting with the first incision at its termination. The flaps are dissected up and disarticulation effected as in the oval operation (Fig. 395).

By the circular method.—Amputation by this method is performed by making a circular incision around the finger on a line with the fold of the skin on the palmar surface. Retracting the skin and fascia, a second incision is made, dividing the soft structures to the bone; these are drawn up and disarticulation is effected as in the other methods.

Amputation of the Little Finger at the Metacarpo-phalangeal Articulation.—*By the oval method.*

Operation.—The little finger can be removed by the oval method, the incision being made on the side above the articulation in preference to the dorsal surface, as on the index finger, the incision extending upward so as to remove the metacarpal bone if required (Figs. 396, 397).

Amputation of the Index Finger at the Metacarpo-phalangeal Articulation.—*By the oval method.*

Operation.—Amputation of the index finger at the metacarpo-phalangeal articulation may be performed by the

oval method, the incision beginning on the side in preference to the dorsal surface, thus forming a more shapely stump.

Fig. 396.

Fig. 397.

Amputation of all of the Fingers at the Metacarpo-phalangeal Articulation.—*By the single flap method.*

Fig. 398.

OPERATION.—The fingers, slightly flexed, are grasped by the operator, the integument firmly retracted, and a slightly curved incision is made from one-half to three-quarters of an inch below the heads of the metacarpal bones. The extensor tendons are now exposed and divided; each articulation is opened and disarticulation completed by dividing the lateral and palmar ligaments. The knife is placed behind the heads of the phalanges (Fig. 398), and a flap is formed by carrying it downward and terminating the incision at the base of the fingers (Fig. 399). The digital arteries are to be ligatured, the tendons retrenched, and the palmar flap drawn over the ends of the bones, which may be removed by the pliers if deemed necessary, and attached by means of sutures.

Fig. 399.

By the circular method.—The integument having been firmly retracted, a circular incision is carried around the base of the fingers, following the depressions in the skin at the commissures. The divided tissues are drawn back and disarticulation effected as in the flap method.

Amputation of the Thumb at the Metacarpo-phalangeal Articulation.

OPERATION.—Amputation of the thumb at the metacarpo-phalangeal articulation may be performed by either the flap, circular, or oval methods, as in the fingers. In performing the operation care should be taken to remove the sesamoid bones connected with the metacarpal bone, and to make the flaps ample in order to cover the digital extremity of the bone, which is broad from side to side.

By the single flap method.

Operation.—Amputation of the thumb at the carpo-metacarpal articulation by this method may be performed by carrying an incision from before backward through the middle of the commissure between the thumb and index finger, the former being abducted, and terminating it at the articulation. Disarticulation is now effected and the external flap is formed by introducing the knife behind and carrying it, in close contact with the bone, to a short distance below the metacarpo-phalangeal articulation. The radial artery may be avoided if the knife, in the first incision, is kept in close contact with the bone at the upper extremity. If divided, the artery, with the digital branches, should be ligatured and the edges of the flaps united by sutures.

Fig. 400.

Fig. 401.

By the oval method.—This operation may be performed by making an incision over the articulation between the trapezium and metacarpal bone, carrying it downward to

the point of junction of the web with the thumb, across the base of the thumb, and then back to a point at the middle of the first incision (Fig. 400). Keeping the knife close to the bone, and separating the tissues carefully, the joint is opened on the dorsal surface, and disarticulation completed by dividing the remaining ligaments. The digital arteries are ligatured, and the flap united so as to form a linear incision (Fig. 401).

Amputation in the Continuity of the Metacarpal Bones.—*By the flap method.*

Operation.—In performing this operation, a curved incision is made across the dorsum of the hand from one side to the other, dividing the structures to the bone. This flap is dissected up, and a flap is made from the palmar surface in the same manner, or by transfixion. The periosteum and interosseous tissues are divided, and a five-tailed retractor applied. The bones are sawn through, vessels ligatured, tendons retrenched, and the flaps united by sutures.

Amputation at the Carpo-Metacarpal Articulation, leaving the Thumb.—*By the single flap method.*

Operation.—The hand being in a position of supination, a small straight knife is entered on the inner border of the hand, at the point of junction of the unciform with the fifth metacarpal bone, and carried obliquely across the palm so as to emerge at a point just below the thumb (Fig. 402). The knife is now carried downward in contact with the bones, and a large convex flap made from the palm. Placing the hand in the prone position, a semicircular incision

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is made across the dorsum, two-thirds of an inch below the line of the articulation, and carried inward and downward, dividing the tissues connecting the thumb and index finger, and joining the first incision (Fig. 403). The flap being

Fig. 402.

Fig. 403.

retracted, disarticulation is effected by dividing the ligaments, beginning on the palmar surface. The radial and ulnar arteries, with, possibly, some of their branches, will require ligature. The tendons are retrenched, and the palmar flap is drawn upward and attached to the dorsal by suture.

Amputation at the Wrist-joint.—Surgical Anatomy.—The wrist-joint unites the forearm and carpus, and, with the exception of rotation, possesses all of the characteristic movements of an enarthrodial articulation.

Bones.—The bones which enter directly into the formation of the articulation are the radius of the forearm, and the scaphoid and semilunar of the carpus (Fig. 389). The ulnar and cuneiform bones participate indirectly, being separated by the intervening articular fibro-cartilage.

Ligaments.—The ligaments of the joint are the external and internal lateral, and the anterior and posterior. The lateral ligaments are attached above to the styloid processes of the radius and ulna, and below to the subjacent carpal bones and annular ligament. The anterior ligament, a broad membranous band, extends from the margins of the lower extremities of the bones of the forearm to the three carpal bones below, thus uniting all of the bones which enter into the formation of the joint. The posterior ligament, less thick and strong, is attached above to the radius, and below to the scaphoid, semilunar, and cuneiform bones.

Muscles.—The tendons of the flexor muscles pass in front of the joint, and the tendons of the extensor muscles behind.

Bloodvessels.—The anterior and posterior carpal branches of the radial and ulnar arteries, with the anterior and posterior interossei and branches from the deep palmar arch, supply the joint.

Nerves.—The nervous branches which are supplied to the joint are derived from the ulnar.

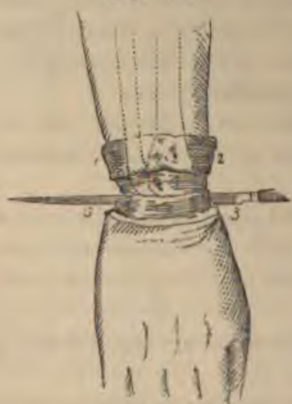
Line of the articulation.—The line of the articulation is curved, owing to the convex surfaces presented by the union of the three carpal bones, which are received into the concave surfaces of the radius and ulna. The marked projections formed by the styloid processes of the radius and ulna are guides to the position of the articulation. It is to be remembered, however, that the styloid process of the radius

projects downward about one-sixth of an inch below that of the ulna. The articulation lies from a sixth to a fourth of an inch above a line passing through the extremities of the two styloid processes, the position of which is further indicated by the middle fold of skin on the palmar surface of the wrist.

Amputation at the wrist-joint may be performed by either the circular or the flap method.

OPERATION.—*By the circular method.*—The forearm being held in a position midway between supination and pronation, a circular incision is made around the limb about an inch below the styloid processes, dividing the skin and fascia. The cuff of skin and fascia being dissected up and turned back to a point above the line of the articulation, a second circular incision is made, dividing the remaining structures to the joint (Fig. 404). Disarticulation is effected by carrying the knife on the posterior part along the curve of the carpal bones, the hand being forcibly flexed. The styloid processes of the radius and ulna may be sawn off on a level with the incrusting cartilages. The radial, ulnar, and interosseous arteries will require ligature. The tendons of the flexor and extensor muscles should be retrenched, and the edges of the flap approximated in the transverse direction.

Fig. 404.



By the single flap method.—The hand being held in a prone position, a slightly convex incision is made from one styloid process to the other across the back, dividing the structures to the bone. The skin is retracted and the joint opened on the dorsal surface. Disarticulation being effected, the amputating knife is placed behind the bones of the carpus (Fig. 405), and carried downward in close contact with them, forming a flap of sufficient length from the anterior surface of the palm (Fig. 406). The styloid processes are

Fig. 405.

Fig. 406.

sawn off, if necessary, the vessels ligatured, tendons retrenched, and the long flap drawn upward over the surface of the bones, and united to the posterior flap by sutures.

By the double flap method.—The hand being slightly flexed, a convex incision extending from one styloid process to the other is made, first on the dorsal, and then on the palmar surface of the hand, forming two flaps, each one inch and a half in length. These flaps are dissected up to the joint, disarticulation performed, and the operation completed as in the previous methods.

Amputation of the Forearm.—SURGICAL ANATOMY.—The forearm is that part of the upper extremity comprised between the arm and the hand, and is composed of two bones, muscles, with bloodvessels, nerves, and other structures.

Bones.—The bones of the forearm are two in number, the radius and ulna—the former placed on the outside and the latter on the inside. The ulna is the larger and longer of the two; its upper extremity is thick and strong, firmly fixed in its position, and enters, by the olecranon process, largely into the formation of the elbow-joint. The lower extremity is small, movable, and, owing to the interposition of the articular fibro-cartilage, does not participate directly in the formation of the wrist-joint. The radius is less in length and size than the ulna; its superior extremity is small, movable, and enters but slightly into the formation of the elbow-joint. The lower end is large and expanded, and forms the chief part of the wrist-joint.

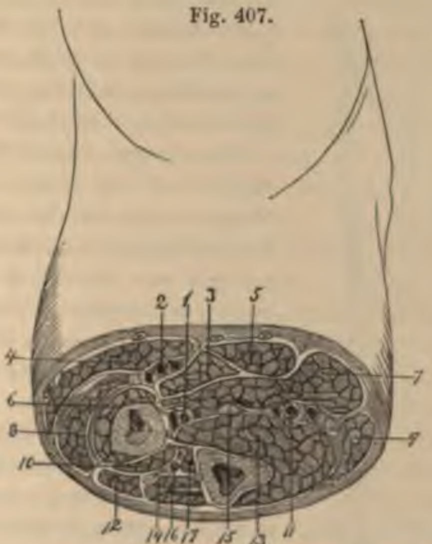
Ligaments.—The radius and ulna are united by two ligaments, the oblique and the interosseous membrane. The former extends from the base of the coronoid process of the ulna, to a point on the radius just below the bicipital tuberosity. The latter, beginning about an inch below the tuberosity, extends between the bones to their lower extremities.

Muscles.—The muscles, which are placed on the anterior, radial, and posterior surfaces of the forearm, are twenty in number, and are classified as flexors, pronators, supinators, and extensors. In the upper and middle portions of the forearm the fleshy bellies of these muscles are placed, while in the lower part they terminate in tendons.

Bloodvessels.—The structures of the forearm are supplied by the radial, interosseous, and ulnar arteries, with their

branches, placed on the outer, middle, and inner surfaces. Numerous large veins ramify in the superficial fascia on the anterior, lateral, and posterior surfaces.

Fig. 407.

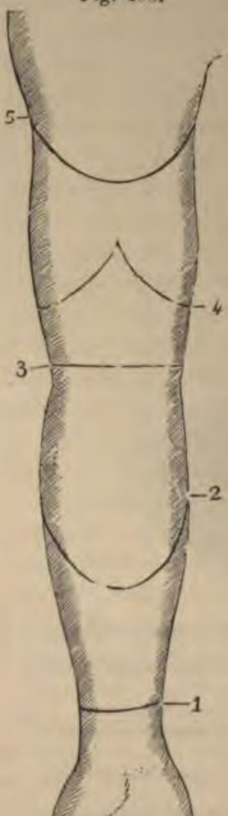


Section through the Middle of the Right Forearm, showing structure.

1. Anterior interosseous vessels and nerves.
2. Radial vessels and nerves.
3. Pronator radii teres muscle.
4. Supinator longus muscle.
5. Flexor carpi radialis muscle.
6. Supinator brevis muscle.
7. Flexor sublimis digitorum muscle.
8. Extensor carpi radialis longior and brevior muscles.
9. Flexor carpi ulnaris muscle.
10. Extensor ossis metacarpi pollicis muscle.
11. Ulnar vessels and nerve.
12. Extensor communis digitorum muscle.
13. Flexor profundus digitorum muscle.
14. Extensor carpi ulnaris muscle.
15. Median nerve.
16. Posterior interosseous vessels and nerve.
17. Extensor secundi internodii pollicis muscle.

Nerves.—The median, ulnar, radial, and interosseous nerves, and their branches, are distributed to the forearm (Fig. 407).

Fig. 408.



Amputation of the forearm may be performed at any point in the upper, middle, or lower third. The rule of saving as much of the limb as possible should be the guide in operations upon this part.

The circular, flap, or rectangular flap method may be employed. In the lower part, the circular or modified circular method is best adapted, owing to the absence, to any great extent, of muscular structures.

In sawing the bones of the forearm, the saw should be applied so as to divide the smaller and more movable bone first. Section of the bones can be facilitated by pressing the thumb between the bones, so as to maintain them in position.

In the lower third.—By the circular method.

OPERATION.—The forearm being held in a position midway between pronation and supination, and the skin retracted, a circular incision is carried around the limb, dividing the skin and superficial fascia (Fig. 408, 1). The cuff of skin and fascia is dissected up, forming a flap equal

in length to one-fourth of the circumference of the limb at the point of section of the bones, and, if necessary, slit up, in order to turn it back. The cuff being held back, a second circular incision is carried around the limb, dividing the muscular structures to the bone. The muscles, with the periosteum, are dissected up to a slight extent, and the interosseous membrane divided. A three-tailed retractor, the middle tail passing through the opening in the interosseous membrane, is applied, so as to thoroughly retract and protect the soft structures, and the saw applied to the bones so as to divide the ulna first. The radial, ulnar, and interosseous arteries will require ligatures. The tendons should be retrenched, and the flap united in a transverse direction.

In the lower third.—By the rectangular flap method.— The forearm being held in a prone position, incisions dividing the structures to the bone are made on either side, beginning at the point of section of the bones and carried down so as to form a flap equal in length to one-half or one-third the circumference of the limb. These incisions are joined at their points of termination by a transverse incision across the posterior surface of the limb, and the flap is dissected up. The short flap, measuring one-fourth the length of the long flap, is formed by making an incision across the anterior surface of the limb. This flap is dissected up, the interosseous membrane divided, and the bones sawn through. The vessels are ligatured and the long flap is drawn over the ends of the bones and approximated to the short flap by sutures.

In the lower third.—By the modified circular method.— This method of amputation may be employed in the lower third of the forearm, the skin and superficial fascia being divided by incisions from without inward so as to form

antero-posterior flaps. These are dissected up and the remaining structures are divided by a circular sweep of the knife. The bones are sawn through and the operation completed as in the flap method.

In the middle third.—By the single flap method.—In this operation the flap is made, by transfixion, from the structures on the anterior surface of the forearm of sufficient length to cover the ends of the bones. The structures on the posterior surface are divided by a slightly convex incision. The remaining steps of the operation are performed as in the circular method, and the anterior flap is drawn over the ends of the bones and united to the posterior flap by suture.

In the middle or upper third.—By the double flap method. —The arm being placed midway between supination and pronation, the point of the amputating knife is entered close to the inner edge of the radius and brought out below at the inner edge of the ulna (Fig. 408, 2). Carrying it downward in close contact with the bones to the extent of half an inch, it is brought obliquely outward, forming a semicircular flap. Re-entering it at the same point as before, a similar flap is made on the outside. The flaps being turned back, a circular sweep is made with the knife around the bones, dividing the remaining structures with the periosteum. The periosteum is dissected up to a slight extent, the interosseous membrane divided, and the retractor applied. The bones are sawn through, the arteries ligatured, and the flaps approximated by suture.

Amputation at the Elbow-joint.—SURGICAL ANATOMY.—The elbow is a true ginglymoid or hinge-joint, uniting the humerus with the radius and ulna.

Bones.—The bones entering into the formation of the joint are the humerus above, and the radius and ulna below. The trochlear surface of the humerus is received in the greater sigmoid cavity of the ulna, whilst the radial head articulates with the cup-shaped depression on the head of the radius (Fig. 409).

Fig. 409.

1. Humerus.
2. Olecranon process of ulna.
3. Head of radius.

Ligaments.—The ligaments of the joints are the anterior, posterior, internal, and external. Together they form a capsular ligament which completely incloses the joint.

Muscles.—The muscles in relation with the joint are, in front, the brachialis anticus; behind, the triceps and anconeus; internally, the common tendon of origin of the flexor muscles of the forearm, and flexor carpi ulnaris; externally, the common tendon of origin of the extensors of the forearm, and the supinator brevis.

Bloodvessels.—Branches of the brachial and anastomosing branches of the brachial with the radial and ulnar arteries, form a network of vessels around the joint.

Nerves.—Branches of the ulnar and musculo-cutaneous nerves supply the joint (Fig. 410).

Line of the articulation.—The line of articulation is irregular, being transverse between the radius and humerus and oblique, from without inward, between the ulna and humerus. The condyles of the humerus are marked prominences, which may be taken as guides to the joint. The external, which is the smaller, is a *quarter* of an inch, and the internal, larger and more prominent, *three-quarters*

Structures in relation with the ant
aspect of the Elbow joint.

should be always borne in m
joint (Fig. 411).

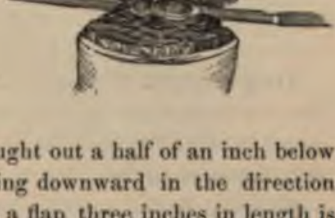
OPERATION.—*By the circ*
held in the position of

second incision is made, dividing the muscles to the joint (Fig. 412). The ligaments are divided and disarticulation completed by severing the attachment of the tendon of the triceps muscle to the olecranon process, or sawing through the process. The brachial artery, and possibly some articular branches, require ligature. The edges of the flap are united in the transverse direction.

Fig. 411.

1. Humerus.
2. Radius.
3. Ulna.
4. External condyle.
5. Internal condyle.
6, 7, 8. Interarticular line.

Fig. 412.



By the single flap method. — The forearm being in a position of supination and slightly flexed, the operator, standing on the inner side of the limb, raises the tissues in front of the joint and enters the amputating knife about an inch below the internal condyle (Fig. 413). Carrying it obliquely across the limb in close contact with the bones of the forearm, the point is brought out a half of an inch below the external condyle. Cutting downward in the direction in which the knife is placed, a flap three inches in length is

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formed. The flap being retracted firmly, a slightly curved incision is made on the posterior aspect extending from the external to the internal angle of the first incision, opening the joint (Fig. 414). The anterior and lateral ligaments

Fig. 413.

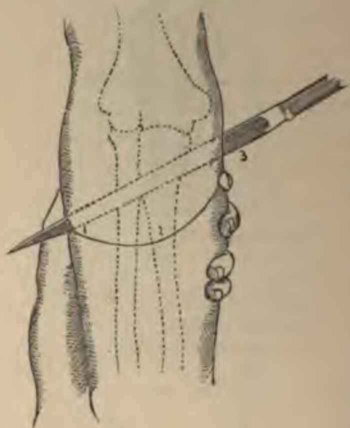


Fig. 414.

are now divided, and the insertion of the tendon of the triceps muscle severed or the olecranon process sawn through. The arteries are ligatured and the anterior flap is drawn over the surface of the bone and secured to the posterior by sutures.

Amputation of the Arm.—SURGICAL ANATOMY.—The arm is that part of the upper extremity which is embraced between the shoulder and elbow. It is cylindrical in form, flattened on the sides, and convex in front and behind.

Bone.—The bone of the arm is the humerus, the longest and largest bone of the upper extremity.

Muscles.—The muscles on the anterior surface of the arm are the coraco-brachialis, biceps and brachialis anticus. On the posterior surface, the triceps and subanconeus.

Bloodvessels.—The brachial artery, passing down on the inner side, supplies, with its branches, the structures of the arm.

Nerves.—The musculo-cutaneous, musculo-spiral, and internal cutaneous are the principal nerves distributed to the arm. The median and ulnar nerves, large trunks, pass down on the inner side, but give off no branches to the arm (Fig. 415).

Amputation of the arm may be performed at any point and by either the circular, flap, rectangular flap, or oval method.

Fig. 415.

1. Biceps muscle.
2. Cephalic vein.
3. Brachial vessels.
4. Musculo cutaneous nerve.
5. Median nerve.
6. Brachialis anticus muscle.
7. Ulnar nerve.
8. Musculo-spiral nerve.
9. Basilic vein, with internal cutaneous nerves.
10. Superior profunda vessels.
11. Inferior profunda vessels.
12. Triceps muscle, with fibrous intersection.

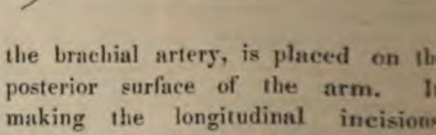
Section through the Middle of the Right Arm, showing structure.

OPERATION.—*In the lower or middle third. By the circular method.*—The arm being held away from the body, a circular incision is carried about it, dividing the skin and superficial fascia (Fig. 408, 3); the cuff of skin and fascia is dissected up to the extent of an inch or two inches according to the size of the limb, and turned back; a second incision is made at the margin of the retracted flap, dividing all of the structures to the bone (Fig. 416). The periosteum, with the muscles, is dissected up, the retractor applied, and the bone sawn through. The brachial artery, with the profunda branches, will require ligature. The edges of the flap are united by sutures in the transverse direction.

Fig. 416.

In the lower third. By the rectangular flap method.—In amputation by this method the short flap, including

Fig 417.



the brachial artery, is placed on the posterior surface of the arm. In making the longitudinal incisions, therefore, it is important to remember to place the one on the inner side, above the line of the brachial artery (Fig. 417). The remaining steps of the operation are the same as those in that upon the forearm (p. 681).

In the upper, middle, or lower third. By the single flap method.—Amputation by this method may be performed at any point, the flap being taken from the anterior, posterior, or lateral surface. The flap is formed by transfixion, being made of sufficient length to cover the end of the bone, while the short flap is made from without inward by carrying the knife directly down to the bone. The operation is completed as in the thigh (p. 646).

In the upper, middle, or lower third. By the double flap method.—In this operation the flaps are of equal length and may be made from the anterior and posterior, or from the lateral surface.

OPERATION.—The arm being at right angles with the body, the tissues are grasped, elevated from the bone, and transfixion is made. Carrying the knife downward in close contact with the bone to a distance of two to two and one-half inches, and cutting obliquely outward, the flap is formed (Fig. 408, 5). Re-entering the knife at the same point, a second flap is made in a similar manner. The retractor is applied and a circular sweep is made with the knife around the bone, dividing the periosteum and the remaining structures. The periosteum is dissected up, the bone sawn through, the vessels ligatured, and the flaps approximated by sutures.

Amputation at the Shoulder-joint.—SURGICAL ANATOMY.—The shoulder-joint is an enarthroidal or ball-and-socket joint, connecting the upper extremity to the shoulder.

Bones.—The bones which form the shoulder-joint are the scapula and the humerus, the globular head of the

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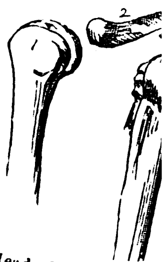

1. Head of the humerus.
2. Clavicle.
3. Acromion process.
4. Infra-spinous fossa.
5. Head of humerus conn
cavity of scapula by ca

Muscles.—The m
above, the supra-spi
triceps; internally, th
spinatus and teres mi
biceps. The deltoid
side

Guides to the articulation.—The acromion process forms a prominent projection above the joint which can be easily recognized. It is placed nearly half of an inch above the glenoid cavity and projects an inch beyond it. The cora-

Fig. 419.

1. Clavicle.
2. Acromion process.
3. Supra-spinatus muscle.
4. Trapezius muscle.
5. Infra-spinatus muscle.
6. Teres minor muscle.
7. Teres major muscle.
8. Latissimus dorsi muscle.
9. Coraco-brachialis and short head of the biceps muscle.
10. Tendon of the subscapularis muscle, blended with the capsular ligament.
11. Pectoralis major muscle.
12. Deltoid muscle.
13. Axillary vessels and nerves.

Section through Right Shoulder-joint, showing structure.

coid process is situated within and lower down, and more nearly in contact with the articulation.

Amputation at the shoulder-joint may be performed by either the oval, single, or double flap method.

By the oval method (Larrey's operation).

Operation.—Elevating the shoulder of the patient and projecting it beyond the edge of the table, a vertical incision, three inches in length, beginning at the apex of the acromion process, is carried downward in the long axis of the arm, dividing the tissues to the bone. From the centre of this incision two oblique incisions are made, one on the anterior and the other on the posterior surface of the arm, extending respectively to the anterior and posterior borders of the ax-

illa (Fig. 420). The flaps thus formed are dissected up so as to uncover the joint. The arm is now rotated outward, and the insertion of the subscapular muscle into the lesser tuberosity divided. The capsular ligament and the long tendon of the biceps muscle are next divided and the arm is rotated inward in order to separate the insertions of the

Fig. 420.

Fig. 421.

1, 2, 3, 4. Wound after Larrey's operation.
5. Glenoid cavity and remains of cap-ular ligament.
6, 6. Axillary vessels.

supra-spinatus, infra-spinatus, and teres minor muscles into the greater tuberosity. Disarticulation is completed by dividing the remaining portions of the capsular ligament, and the amputating knife is placed behind the bone, and the two oblique incisions are joined by a transverse incision, which divides the structures containing the axillary artery (Fig. 421). The artery should be seized as soon as divided, and

ligatured. The anterior and posterior circumflex arteries, with, possibly, other articular branches, will require ligature. The edges of the wound are approximated, so as to form, when union has occurred, a linear cicatrix.

By the oval method (Spence's operation).—An incision three inches in length, is made on the inside of the arm, from a point just external to the coracoid process downward, passing in the line of separation between the deltoid and clavicular portion of the pectoralis major dividing these as well as the tendon of insertion of the latter muscle; from the lower end of the vertical incision the knife is carried, in a slightly curvilinear direction, outward, dividing the fibres of the deltoid muscle, to the posterior border of the axilla. A third incision is now made, from the junction of the first and second, on the inner surface of the arm, dividing the skin and fascia *only* to join the incision made on the outer surface. The flap on the outer surface can now be raised, exposing the articulation; the capsular ligament, with the long tendon of the biceps and the points of insertion of the supra-spinatus, infra-spinatus, and teres minor into the greater tuberosity and that of the subscapularis into the lesser tuberosity, should be divided, disarticulation effected, and the anterior and posterior incisions joined by section of the tissues containing the axillary artery. The vessels should be ligatured in the same manner as in the Larrey method. The advantages claimed for this method of operation are a better formed stump, the division of smaller articular branches, and the ease with which the joint is exposed.

By the single flap method (Dupuytren's operation).—In this operation the flap, which is formed from the deltoid muscle, may be made either by transfixion or by cutting

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muscle raised from the bone, the knife is carried downward in close contact with the bone, forming a posterior semi-circular flap three inches in length. Disarticulation is effected, and the knife passed behind the bone, and the

Fig. 422.

Fig. 423.

anterior flap, of the same length as the posterior, is made by carrying it downward and forward, dividing the structures which contain the axillary artery (Fig. 424). The arteries are ligatured and the flaps approximated by sutures.

In amputation of the forearm or at the elbow the arterial circulation may be controlled by digital compression of the brachial artery in the middle of the arm, or by the appli-

cation of the tourniquet over a compress at the same par
Esmarch's bandage may be used as in the lower extremity

Fig. 424.

In amputation of the arm or at the shoulder-joint, th
subclavian artery may be compressed against the first ri
by the handle of a key well padded. The hemorrhage ma
also be controlled by carrying the narrow band of th
Esmarch apparatus around the axilla close to the body.

PART VII.

EXCISION OF BONES AND JOINTS.

THE terms *Excision*, *Exsection*, and *Resection* may be applied without distinction to operations having for their object the removal of the articular extremities of bones, or of bones in part or whole. The operation has been performed from an early period of time in those cases in which the local character of the injury or disease did not demand removal of the limb or part of it by amputation.

The general adoption by surgeons of the operation in proper cases has without question contributed largely to the preservation of both life and limb. The table of statistics compiled by Heyfelder, of St. Petersburg, and published in 1861, shows that in 1280 cases of excisions of bones, 932 recovered, 266 died, and 82 failed, giving a percentage of deaths amounting to 36.04. Of 961 excisions of joints 684 recovered, 186 died, 91 failed, giving a percentage of deaths of 36.78. The table prepared by Prof. S. W. Gross of excision of the shaft of bones for gunshot injuries in 1657 cases gives the percentage of deaths at 23.47. In 3596 cases of gunshot injuries of the joints in which excision was performed the percentage of deaths, as reported by Prof. Gurlt, of Berlin, was 33.92. The mortality, in nearly 6000 cases of amputations is shown by Mr. Lane to be 36.92 per cent.

An examination of the tables, the results in which are

quoted above, shows that of the bones, the greatest mortality followed excision of those of the face, and of the joints, the hip gave the highest mortality, and the ankle, the lowest.

The *conditions* which indicate the employment of excision, as an operative measure, may be *traumatic* or *pathological*.

Shaft or Body of the Bones.—The *traumatic* conditions occurring in the shaft or body of the bones are—

Protrusion of the fragments, to such extent, in compound fractures as to prevent reduction, in which excision of portions of the protruding ends may be required.

Comminution of the bone in fracture or gunshot wounds may require the removal of the portions comminuted and deprived of periosteum.

The *pathological* conditions are chiefly those due to caries or necrosis in which excision is necessary in order to stop suppurative action and permit repair to occur.

In ununited fractures excision may be practised as a method of treatment. It may also be performed for the relief of deformity after union in fracture or where it may be desirable to straighten a bone in rachitis.

Articular Extremities.—The *traumatic* conditions occurring in the *articular extremities* of bones which demand excision are quite numerous.

Fractures involving the joints are frequently of such nature as to necessitate the removal of the fragment or fragments in relation with the joint.

In compound dislocations it may be necessary to excise the displaced articular end in order to effect reduction.

Excision of the head of the bone may be indicated in old unreduced dislocations in which great pain is experienced from pressure upon nerves.

The *chief pathological condition* which demands exci-

sion is chronic inflammation of the joints in which all of the structures are involved, with erosion of the articular surfaces and very great suppuration, producing severe constitutional disturbance.

Excision may also be performed to relieve the great deformity which sometimes attends anchylosis of a joint, or in certain forms of club-foot, irremediable by other means.

Contra-indications.—The conditions which contra-indicate the performance of excision are, extensive involvement of the articular surfaces, which, if removed, would leave the limb useless, the existence of malignant disease, the presence of *acute* inflammation, structural disease of the lungs or kidneys, symptoms of osteo-myelitis, and rapid extension of the articular disease indicating a constitutional vice. In addition it may be stated that excision may be performed with safety to relieve conditions involving the articulations of the upper extremity, which would contra-indicate interference in the hip and knee-joint. The age of the patient is also to be considered; the tendency to recovery exists to a very marked extent in the young, and in these excision should not be resorted to at too early a period of the disease. Old age is a contra-indication, owing generally to the feeble character of the reparative processes.

Process of Repair after Excision.—After excision of the articular surfaces of bones, or of a portion of a bone, if the surfaces are kept in apposition, an immobile osseous union will occur as in fractures. If the cut surfaces are more widely separated and if motion is maintained, the ends will be attached by a dense fibrous band, forming a false joint. This condition is favorable in excisions performed upon the joints of the upper extremity in which it is desirable to preserve the prehensile function of the limb. In these joints

In the excision of an entir
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In performing excisions, th

periosteal elevators (Figs. 427, 428), shield of wood or sole leather to place between the bone and soft tissues during section of the bone, saws of different kinds—that of Mr.

Fig. 425.

Fig. 426.

Fig. 427.

Fig. 428.

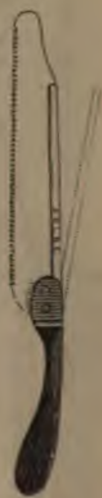
Butcher is especially designed for the purpose, having a narrow reversable blade; the semi-circular saw of Mr. Hey, a small metacarpal saw (Figs. 429, 430, 431, 296), and a chain saw with handles or fastened to a frame (Figs. 432,

433). To seize and obtain firm hold of the bone during di section a number of strong forceps with various curves wi

Fig. 429.

Fig. 430.

Fig. 431.



be required (Fig. 434, 435). Cutting pliers, straight an curved, are also needed to cut away spicula of bone and t divide small bones (Figs. 297, 436, 437, 438, 439). Chisel scrapers, and gouges of various forms, with a metal malle will be required to scrape away and gouge out diseased bon

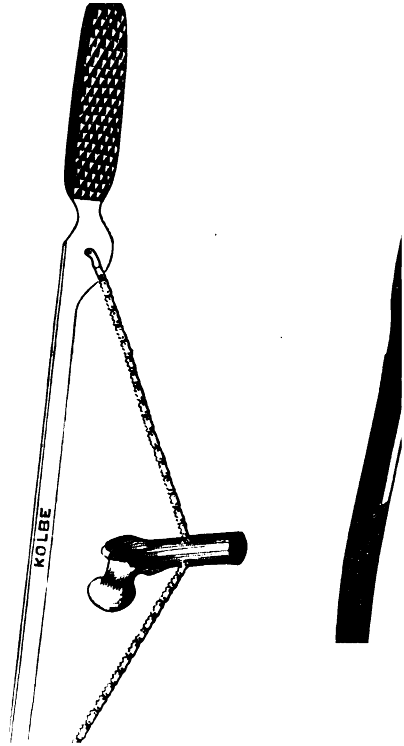
(Figs. 440, 441, 442, 443). A tourniquet may be placed over the main artery to control capillary bleeding during

Fig. 432.

the operation. An Esmarch bandage applied to the limb secures a bloodless field of operation. Large bloodvessels are not usually divided in operations of excision, as the dissection of the soft tissues is generally made at points removed from their position.

A syringe to wash out the wound should be provided. In performing excisions, as in other operations, proper preparations should be made beforehand. The instruments, dressings, and all articles needed during the operation should be arranged and placed in convenient places; the assistants, usually four or five, should be instructed in their duties. As a rule, the patient should occupy the recumbent position.

The *incisions* made in reaching the part of bone to be excised vary according to the situation of the joint or bone. A straight or slightly curved incision may be employed in the excision of any joint or bone. The H and square in-


KOLBE

in proper apposition, whereby the process of healing is delayed. When it is necessary to include diseased tissue in the

Fig. 436.

Fig. 437.

Fig. 438.

incision the elliptical form may be employed. Care should be taken to avoid retrenchment of the flaps, as sufficient shrinking usually occurs to adapt them to the parts.

The *section* of the bone is made after it has been completely exposed by the incision and denuded of its periosteum which, as stated above, is a difficult and tedious operation in accidents and acute conditions, but much less so in those of a chronic character. When the chain saw is used the bone need not be lifted from its place, the chain being readily slipped beneath it by an eyed probe armed with a

saw is employed, the bone should b
and supported upon a soft wooden sh
In operations done upon the forear
taken that the bones are divid

section should always be *outside* of the insertion of the ligaments, as experience has shown that inflammation is very

Fig. 442.

Fig. 443.

liable to occur if any portion of the ligaments is left. In every instance the section should be made through healthy bone, otherwise a speedy return of the disease will ensue. If the periosteum is found detached from the surface, the uncovered portion of the bone should be excised, as exfoliation is liable to follow in such cases. The saw should be used in dividing the bone in preference to the cutting pliers, as this instrument produces contusion of the parts, with more or less irregular edges.

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jection, should be given to allay
is prone to follow the operation
repair. Should suppuration ens
and good diet should

SPECIAL EXCISIONS.—SKULL.

Cranium.—SURGICAL ANATOMY.—The bones of the head, or cranium, are so articulated as to form a cavity in which is lodged the brain and its membranes. The articulations are of the synarthrodial or immovable variety, and bind the different bones firmly together. The external surface of the vertex and sides of the cranium are covered by the integument, which is thick in this portion and studded with hair follicles; by the superficial fascia, a firm, dense membrane intimately adherent to the integument, and to the occipito-frontalis muscle and its aponeurosis, and by the occipito-frontalis muscle which, with its tendon, extends from the occiput to the eyebrow, covering one side of the entire vertex, the muscular portions extending from an inch and a half to two inches, the frontal portions being the longer. On the sides, the temporal muscles occupy the temporal fossæ covered by the strong and dense fascia which is attached to the temporal ridge. Covering the surfaces of the bones is the pericranium, a delicate periosteal membrane. The arterial supply to the scalp on the top and sides is furnished by the anterior and posterior temporal and occipital arteries. The nerves are derived from branches of the supra-orbital, temporal, auricularis magnus, and occipitalis major and minor. The flat bones forming the vertex consist of two compact layers, with the spongy or diploic tissue between. The external table is strong and dense, while the internal or the *vitreous* is very brittle. The diploic tissue contains a number of sinuses or venous channels which ramify in tortuous directions throughout the structure, being composed of the frontal, anterior and posterior temporal, and occipital. The internal surface of the cranial bones is lined

by the dura mater, the fibrous membrane of the brain, which forms the internal periosteum. The dura mater contains the meningeal arteries and their branches, and the superior longitudinal and lateral sinuses, two large venous channels having important surgical relations. The superior sinus occupies the attached margin of the falx cerebri, beginning at the crista galli and passing backward, terminates at the internal occipital protuberance in the lateral sinuses. In its course, it grooves the inner surface of the frontal bone, the apposing margins of the two parietal, and the superior portion of the crucial ridge of the occipital bone. The lateral sinuses begin at the torcular Herophili, a slight distance to the side of the internal occipital protuberance, and are lodged in the attached margin of the tentorium cerebelli. As they pass to their termination in the jugular foramina, they rest upon the inner surface of the occipital bone, the posterior inferior angle of the parietal, the mastoid portion of the temporal, and the upper surface of the jugular process of the occipital. The position of these important vascular channels should be borne in mind in all operations upon the vertex and the mastoid portion of the lateral region.

The thickness of the cranial walls differs at different points, being thickest at the protuberance of the occipital bone and thinnest in the temporal region and roofs of the orbits. The cranial bones of different individuals vary greatly in this respect. In some they are very thin, fracturing under the application of the slightest force. In others, especially in negroes, the bones are sometimes found to be very thick, measuring frequently one-quarter to one-half of an inch at all points.

The *conditions* which demand excision of portions of the cranial walls are necrosis, morbid growths, intracranial

collections of blood or pus, the removal of foreign bodies, as bullets or fragments of knife blades, the relief of epilepsy or insanity due to bone pressure, and fractures causing depression of the bone, with symptoms of brain compression, or injury to the brain by rough edges or spicula of bone. In necrosis and morbid growths, the disease may be limited to the external plates, and relief may be afforded by removal of this portion of the bone alone. In operations for the removal of intracranial collections of blood or pus, or of pressure by bone, either recent or chronic, the opening into the cavity is made through both plates of bone by the trephine, or where a compound fracture exists the bone may be elevated and excised with the pliers. The question with regard to the employment of the trephine in cranial injuries is one of great importance, and its discussion has recently taken a wide range.

It may be stated in general that excision of the cranial bones is indicated and should be performed in the adult in all instances of injury which are accompanied by depression of the bone and symptoms of compression; in compound fractures with symptoms of compression, with or without depression; it may be proper in similar cases, with depression and without symptoms of compression; in compound comminuted fractures with depression; in punctured fractures; in compound fractures, in which inflammatory symptoms develop, which may be due to spicula of bone pressing upon the brain. In the child, owing to the comparative thinness of the cranial walls and the accompanying elasticity by reason of which depression may occur without fracture and without the occurrence of marked brain pressure, the use of the trephine is rarely required. Under the process of growth and development the brain may accommodate itself to the altered shape of the cranial wall. In all cases, where

it is possible, the forceps and elevator, with the pliers, should be employed in preference to the trephine.

The gravity of the operation does not exist in the effect upon the bone, but in that exerted upon the important and sensitive organ and structures within the cavity surrounded by them. Section of the external and internal plates with the intervening diploic structures may be regarded as an operation of no greater gravity than that of the compact and cancellated tissue of a long bone. The primary and secondary effects exerted upon the brain and its membranes by the cranial injuries which are amenable to relief by the operation upon the bones, give to it an importance not possessed by any other.

Fig. 444.

Fig. 445.

The *instruments* required for the performance of excision of the cranial bones consists of a scalpel (Fig. 242), dissecting, artery (Figs. 434, 435), and bone forceps (Fig. 435), a tenaculum, trephines, cylindrical and conical in shape, and

of different diameters (Figs. 444, 445, 446), a probe with a flat end, a brush to remove the bone dust from the teeth of the trephine (Fig. 447), an elevator (Fig. 448), a lenticular (Fig. 449), a Hey's saw (Fig. 450), a Holsen chisel (Fig. 451), ligatures, sutures, and needles. The crucial

Fig. 446.

Fig. 448.

Fig. 449.

Fig 450.

Fig. 451.

Fig. 447.

incision has been usually employed in the section of the scalp, but it is not as advantageous as that semilunar or horse-shoe shaped in form.

OPERATION.—The patient having been placed in the recumbent position with the head elevated, an anæsthetic is administered and the hair removed by the razor for some

distance around the wound. If the patient is unconscious by reason of the compression exerted by depressed bone or other cause, the anæsthetic may be withheld. If a wound of the scalp exists, it may be enlarged in the necessary directions, or a horse-shoe shaped incision may be made carrying the knife to the bone and reflecting the flap thus formed (Fig. 452). Bleeding from the divided vessels of the scalp may be controlled temporarily by the hæmostatic forceps and usually permanently, without difficulty by the sutures employed in closing the wound, in this manner dispensing with ligatures. If a depression of the bone exists the trephine should be applied over the border of the depression, the pin of the instrument being pushed down into the sound bone. A circular incision of the pericranium should be made before application of the instrument. The trephine having been fixed in position by the pin, it should be revolved by a movement of supination and pronation of the hand until a slight groove is made by the teeth, when the pin should be retracted and held firmly in this position by the screw (Fig. 445). The instrument should be re-applied and the section of the bone cautiously proceeded with. The bone dust should be removed from the teeth of the trephine by the brush or a wet sponge and the groove in the bone cleaned by the flat end of the probe. Section of the diploë will be indicated by the flowing of blood into the wound; from this point great care should be exercised during section of the

Fig. 452.

thinner internal table. The button of the bone should be grasped by the forceps and gently moved in order to ascertain when it is entirely free. It may be removed in the opening of the trephine or picked out with the forceps. After removal of the section of bone, the wound is gently cleansed, the flap replaced, and secured by silver wire sutures, sufficient intervals being left for the escape of the wound fluids. The wound should be dressed antiseptically, and the treatment of the patient conducted so as to avoid the occurrence of inflammation.

In compound and comminuted fractures, the fragments of bone may be removed with the bone forceps and elevator, the use of the trephine being dispensed with. This plan should always be adopted when practicable. In a case of compound comminuted fracture of the frontal and parietal bones, under my care some years since, I removed, in this manner, twenty-four fragments of bone, varying in size, the largest fragment being the size of a silver dollar, and detached from the internal table. In a number of instances of compound and comminuted fractures of the cranium, I have succeeded in effecting removal of the fragments and elevation of the depressed bone with the forceps and elevator. If possible to avoid it, the trephine should not be applied over the course of the longitudinal or lateral sinuses,* or their point of union at the occipital protuberance; over the frontal sinuses, or the anterior inferior angle of the parietal bone, at which point the middle meningeal artery enters the cranial cavity. When the condition demands operation at these points care should be taken to avoid wounding these important vessels. Hemorrhage from a sinus may be controlled by pressure with a compress of lint for a few hours, or, if necessary, a double lateral ligature may be applied.

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FACE.

Malar Bone.—SURGICAL ANATOMY.—The malar bone, one of the double bones of the face, is situated at the upper and outer part of the face, and enters into the formation of the orbit and zygomatic and temporal fossæ. It articulates with the frontal, sphenoid, and temporal bones of the cranium, and the superior maxilla of the face. Its position is quite superficial, and its relations, except to the [illegible] fissure, are not very important. [illegible] arteries and nervous branches traverse canals in its substance.

It may be the seat of [illegible] and other fractures of the bones of the face [illegible] sion. It is frequently removed [illegible] in operations of excision of the upper jaw.

The bone may be exposed by a [illegible] from the external angle of the [illegible] to the maxillary process.

OPERATION.—When [illegible] as an independent operation, it may be exposed by the [illegible] given above, the periosteum [illegible] and the frontal, zygomatic, and maxillary processes [illegible] and the bone grasped with the [illegible] gun-shot fractures the fragments which are [illegible] may be removed with the forceps. [illegible] be [illegible] by [illegible] in position by [illegible]

Upper Jaw.—[illegible] tion of the upper jaw [illegible] the [illegible] of a [illegible]

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by pressure and involve in their removal the greater portions of the bone.

Osseous tumors existing in their simplest form, as an hypertrophy of the whole or a part of the jaw, or as the result of the transformation of pre-existing growths, compels the excision of those parts involved.

Sarcomatous tumors require extirpation of the entire jaw, or free excision in those of the less malignant character.

Carcinoma of the jaw, of whatever form, demands the removal of the entire bone. A difference of opinion exists with regard to the propriety of operative interference in carcinomatous affections of the upper jaw. The difficulty, in advanced cases, of obtaining complete removal of the diseased tissue and the speedy recurrence of the growth in the majority of cases after operation, suggest grave doubts as to the benefits to be derived from an operation, in itself, of a serious character. In the early stages, the growth may occupy an area so circumscribed as to permit of its entire removal, the patient gaining, if not complete relief, at least an immunity of longer duration than when the disease is attacked after its full development. Secondary operations should not be performed, as it is impossible to reach, after recurrence, the limits of the disease.

Operation.—The patient should be placed in the semi-recumbent position upon a firm table and an anæsthetic administered. The instruments required for the operation are scalpel, dissecting forceps, cutting pliers of various angles (Figs. 297, 437), strong forceps, among them the lion-jawed forceps (Figs. 454, 455), the metacarpal, Hey's or Adams's saw (Fig. 456), chisels, gouges, and retractors. Sponge-holders should be provided, in order that sponges may be carried into the mouth and pharynx to remove the blood and prevent its passage into the larynx.

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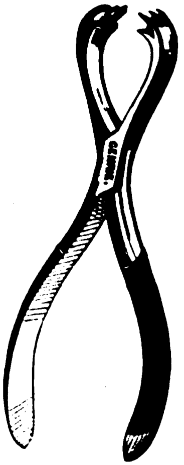
Fig. 454.



of the operation, and subsequently to extended paralysis of the muscles of the face. It is a matter of some importance also to avoid section of the duct of the parotid gland (Steno's duct), which, if made, may result in the formation of a salivary fistula. The incision, at first employed, began at the angle of the mouth, and was carried in a curved direction across the cheek, to the malar bone or external angle of the frontal bone (Fig. 457, 1). To this incision has been added another, which is carried from the point of termination of the first beneath the inferior border of the orbit to the side of the nose. By these incisions large branches of the facial artery and nerve are divided. In order to avoid section of these large branches, Sir William Fergusson suggested and employed a line of incision, which began at the middle of the upper lip, and was carried to the columnæ nasi and round the ala of the nose to the inner angle of the eye and from this point beneath the inferior border of the orbit to external angle of the frontal bone (Fig. 457, 2). This incision divides the artery and nerve where their branches are smallest and the flap formed is extensive enough to uncover the entire surface of the jaw. The only objection to be offered to this line is the formation of angles, the edges of which are difficult to approximate accurately and in the union of which the reparative process is slow. To overcome this objection I have employed a curved incision which begins near the angle of the mouth, passes along the ala of the nose to near the inner

Fig. 457.

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Fig. 458.

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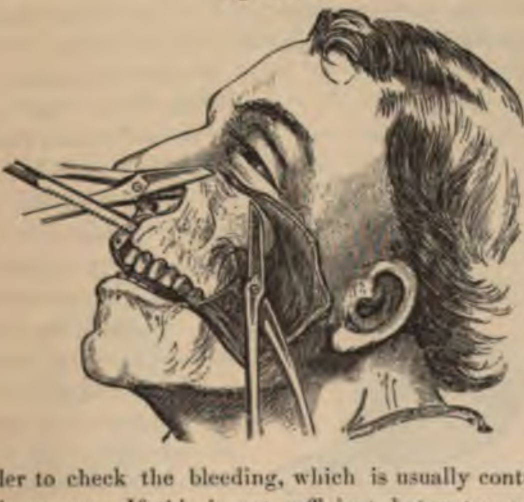
nose for that purpose (Fig. 459). The bone is now seized with the lion-jawed forceps (Fig. 454), forcibly depressed and abducted and adducted so as to separate the suture between the pterygoid process of the sphenoid bone and palate bone, and also the articulations within the orbit, the tissues occupying the floor of the orbit having been detached with care and pushed up with the handle of the knife. As soon as the bone is removed sponges, which have been prepared antiseptically, should be pressed into the wound with some force

Fig. 459.



in order to check the bleeding, which is usually controlled by this means. If this is not sufficient, hot water may be employed to stop the general oozing, and animal or carbolized silk ligatures should be applied to the arteries requiring them. The hemorrhage having ceased, the cavity should be cleansed and packed with 77½ per cent. iodoform gauze and the flaps replaced and sutured with silver wire, the incision in

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Fig. 460.

allowed to remain in position by making a section of the bone with the saw, just beneath the lower border of the orbit.

The application of ligatures is rarely needed in this operation, providing care has been exercised to make the incisions beyond the limits of the morbid growths involving the bone. The larger arterial branches of the deeper parts are sufficiently removed from the seat of operation to escape injury, except in an unusual involvement of the parts in the morbid growth. The preliminary application of a ligature to the common carotid artery can scarcely be required in any case.

The *prognosis* in excisions of the superior maxilla is exceedingly favorable. Heyfelder's tables give 26 deaths in 112 complete excisions, 36 in 187 partial excisions, and 5 in 12 excisions of both bones. Prof. S. D. Gross performed the operation upwards of twenty times without a single loss. Of eight excisions performed by the author, one, a case of large medullary carcinoma, terminated fatally two weeks after the operation. No difficulty in controlling the hemor-

Fig. 461.

Fig. 462.

rhage occurred in any of the cases, and in but one was it necessary to apply any ligatures. Figs. 461, 462 show the appearance presented in a sarcoma of the upper jaw of the

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case, it should be detached

OPERATION. Th

symphysis and thence upward to the border of the lip or through the entire lip. In excision of the entire jaw the incision should be carried to the lobe of the ear of the opposite side. In partial excisions but a portion of the incision is required. In necrosis, and affections limited to the alveolar border, excision can be performed through the mouth and without external incision. The incision along the base will necessitate division of the facial artery, which may be secured, before section, by a hairlip pin introduced beneath the vessel and a ligature applied over it in the manner of the twisted suture. The bone having been exposed by the dissection of the overlying tissues with the masseter muscle, it should be divided by the chain saw, which should be carried beneath it by a threaded needle at such point as is required. The muscles attached to the inner surface of the base and angle, with the periosteum, if deemed advisable, should be detached with a probe-pointed bistoury or with the periosteal elevator, care being taken in excision of the entire jaw to secure the frænum of the tongue with a ligature before separation from the bone, in order to prevent its retraction, which might result in closure of the glottis and suffocation (Fig. 463). Separation of the temporal muscle, from the coronoid process and of the condyloid process from the glenoid fossa at the point of articulation is one of the most difficult steps of the operation. The intimate

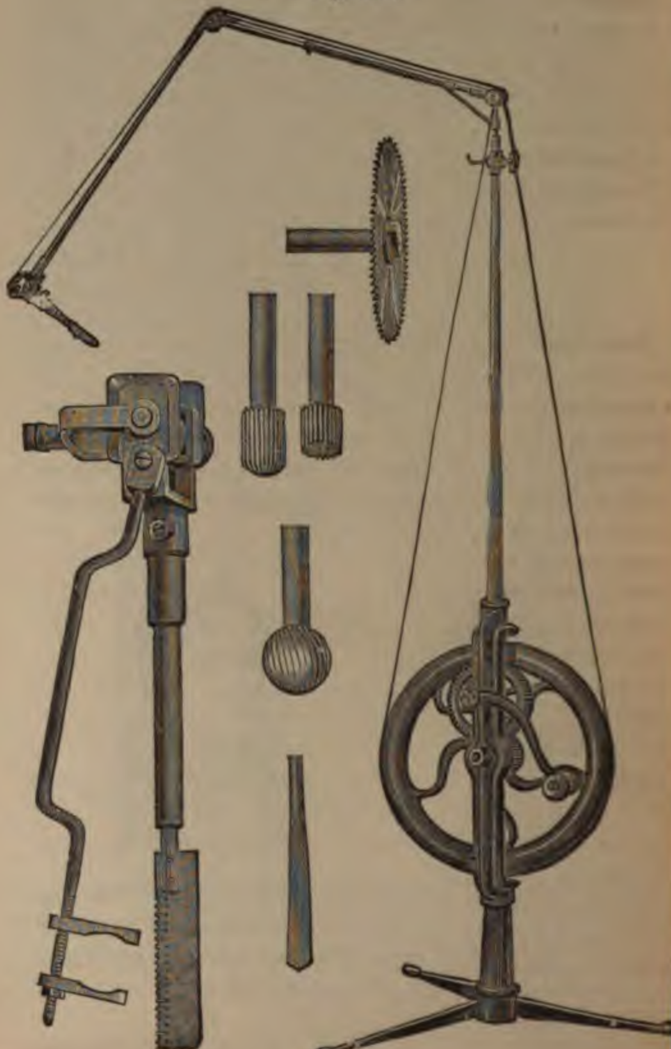
Fig. 463.

relation of the internal maxillary artery to the condyle, pass ing, as it does, on the inner side of the neck of this process, ren ders it liable to injury unless the knife is used with great cau tion. Although the vessel is further removed from the coronoi process, lying to the inner side and behind, it may be wounde in the unguarded use of the knife. For the purpose of divisio of the tendon of the temporal muscle and capsular ligament of the joint, the probe-pointed bistoury—that used in herni is preferable—should be applied, cutting the tendon from without inward and the ligament upon the outer side alone. This partial section is usually sufficient to permit the bone to be detached by seizing the body and forcibly twisting it outward. In excision of the lower jaw through the mouth the tissues lying in front of the anterior border of the ramus

Fig. 464. Fig. 465.

may be cautiously divided with the probe-pointed bi the incision being made upward until the base of th noid process is reached, and then section of the ten

Fig. 468.



so complete as to prevent deformity by preserving the shape of the jaw and supplying a firm support for artificial appliances. This is seen in Figs. 466 and 467, representing the conditions in a case of phosphorus necrosis in which one-half of the lower jaw was excised.

In operations upon both the upper and lower jaws Bonwill's surgical engine, with properly adapted burrs and saws, may be employed with advantage (Fig. 468).

TRUNK.

Sternum and Ensiform Cartilage.—SURGICAL ANATOMY.—The sternum, with the costal cartilages, forms a portion of the anterior wall of the thorax. It consists of delicate cancellated tissue covered by a compact layer in front and behind. A number of muscles are attached to it, chiefly by aponeurotic points of origin. Its anterior surface is subcutaneous, being covered by the skin, fasciæ, and aponeurosis of the two pectoralis major muscles. Its posterior surface has an important relation with the anterior mediastinum, forming its anterior wall, with the pleuræ on the sides and the pericardium behind. In this space, the internal mammary vessels of the left side are placed with a quantity of loose areolar tissue, in which inflammation, leading to suppuration and the formation of post-sternal abscesses, sometimes occurs. In operations upon the sternum, the proximity of the pericardium should be borne in mind, and care should be exercised in the use of cutting instruments upon the posterior surface.

The *conditions* requiring excision, which are, as a rule, partial in character, are caries and necrosis, abscess in the anterior mediastinum, gunshot injuries, with lodgement of

foreign bodies in the substance of the bone or in the mediastinum. In rare instances, where harmful pressure is exerted by the displaced fragment or portion in fractures or dislocations excision may be necessary. In extensive comminution of the bone by shot wounds, the pericardium may be exposed on removal of the fragments. It is always desirable to make the operations subperiosteal as far as possible, in order that a support may be afforded by new bone formation.

OPERATION.—A *longitudinal line of incision* is usually sufficient to expose the bone for any operation. A *crucial* or *semilunar* may be employed, if deemed advisable. The diseased bone may be removed by the gouge, cutting pliers, Hey's saw, or the trephine. A drainage tube should be introduced, especially if the wound is large, and antiseptic dressings applied. It is very important to afford an easy outlet to the wound fluids lest they should dissect up the tissues posteriorly and enter the mediastinal space.

Rib and Costal Cartilages.—SURGICAL ANATOMY.—The ribs, twelve in number on each side, form the chief part of the walls of the thoracic cavity. From the second to the twelfth they are placed obliquely, the costal extremity being lower than the vertebral. The spaces between them are filled up by the intercostal muscles. In structure the ribs consist of cancellated tissue covered by a thin external compact layer. They have important relations with the pleura, being separated from it on the inner surface by a delicate areolar tissue. On the outside they are covered by the integument, fasciæ, and muscular layers. The intercostal vessels lie in a groove on the inferior border.

The *conditions* which may require excision of the ribs and

their cartilages are caries, necrosis, comminuted fractures, collections of pus in the pleural cavity, and morbid growths. A number of ribs may sometimes be involved, requiring operation. It is seldom that the entire bone demands removal.

Line of incision.—In cases of caries and necrosis the incision may be made in the long axis of the rib following its curve. Where more than one rib is involved a semilunar or crucial incision may be required to expose the bones. For the removal of tumors connected with the ribs an elliptical incision should be made. When resection is performed to evacuate pus from the pleural cavity, a straight or semilunar incision will fully expose the part.

OPERATION.—The patient should be placed in the recumbent position, turned slightly upon the sound side, and an anæsthetic should be administered. When the operation is performed for caries or necrosis, the incision should be made directly to the bone, dividing the periosteum, which, in these cases, is much thickened by inflammation. This membrane should be separated from the bone by the elevator, which should be kept in close contact with the bone to avoid wounding the pleura or intercostal vessels, and the caries removed by chisel or gouge, or in case of necrosis, the rib divided either by the chain saw, which may be passed around it, by the metacarpal saw, a shield being passed beneath it to protect the adjacent tissues, or with the pliers. After section, the rib should be lifted from its position, drawn out, the periosteum detached from its posterior surface, and the bone again divided by the saw or pliers.

In excision of the ribs for morbid growths great care should be exercised in separating the posterior attachments, which are, as a rule, intimately adherent to the pleura, and

perforation of which may occur. Hemorrhag
intercostal arteries may require application of t
carried around the rib, if necessary.

Drainage having been provided for, the woun
closed by suture, dressings applied and retained
adhesive strips or broad bandages carried aroun

Pelvic Bones.—SURGICAL ANATOMY.—Tl
that portion of the trunk interposed between
extremity of the vertebral column, to which it a
port, and the lower extremities, upon which it r
formed of four bones, the two ossa innominata, t
and the coccyx. Externally it is covered by t
ment, fasciæ, and layers of thick muscles which ar
to its surface, borders, and prominences; within
by fascia and partially by muscles and the periton

The *conditions* which demand excision of the pe
are necrosis, morbid growths, compound commin
tures and, in the coccyx, a condition of neuralgia fo
some cases, fracture or dislocation of the bone.

The *line of incision* may be straight or curved
to the position of the growth or dead bone.
exists these may be enlarged in any direction and
extracted through the opening.

OPERATION.—The patient should be placed upo
or in the semi-prone position and the incision made
of necrosis, directly to the bone, dividing the pe
which should then be separated by the elevator.
occupying the surface of the bone may be expos
elliptical incision and the growth removed by the
gouge. In compound comminuted fractures, the f

which have no periosteal attachment may be removed through the external wound.

COCCYX.—Coccygectomy, excision of the coccyx, may be required in cases of coccygodynia, or painful neuralgic affection of the coccyx, and in necrosis. The bone may be exposed by an incision carried in the middle line from the sacro-coccygeal junction two inches downward toward the anus. The periosteum should be carefully detached with the periosteotome or elevator, the index finger of the left hand being kept meanwhile in the rectum to guard against wounding the bowel. It will be found frequently quite difficult to effect separation of the bone without breaking it up into small fragments, and in this way accomplishing extraction. In two of the three excisions of this bone which I have performed, I experienced this difficulty; in the remaining operation, for necrosis, the bone was easily lifted from its position. A drainage tube should be introduced extending the entire length of the wound and emerging at the upper and lower angle, in order to secure perfect drainage and douching of the cavity. The wound, as in excisions of other portions of the pelvis, should be closed by suture and the dressings retained by adhesive strips or a broad bandage.

UPPER EXTREMITY—SHOULDER.

Clavicle.—SURGICAL ANATOMY.—The clavicle is placed between the sternum and scapula, articulating by its inner extremity with the manubrium of the sternum and cartilage of the first rib, and by its outer end with the acromion process of the scapula. It receives the attachments of the sterno-cleido-mastoid, sterno-hyoid, pectoralis major, subclavius, trapezius, and deltoid muscles. It has most import-

ant surgical relations, by the posterior surface of
two-thirds, with large arterial and venous trunks, n
the right lymphatic and thoracic ducts. Posteri
sterno-clavicular articulation on the right side, th
tion of the innominate artery into the common ca
subclavian occurs, with the junction of the intern
and subclavian veins, which, with numerous small
and veins, form a vascular network which greatly c
any operations in this region. On the left side, th
carotid and subclavian arteries, with the internal ju
subclavian veins and smaller arteries and veins, gi
region also important surgical relations. The ant
face of the bone is nearly subcutaneous in its entir
being covered in addition by the platysma muscle c

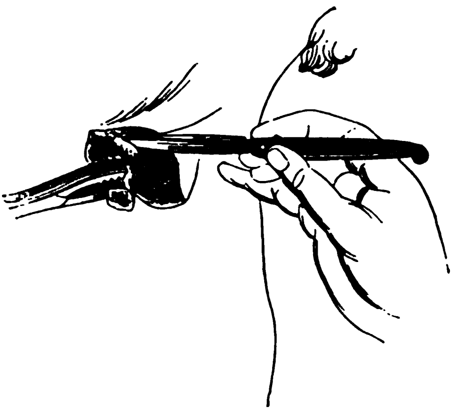
The *conditions* which demand excision of the
caries, necrosis, pathological displacements of the
extremities, and morbid growths.

The incision necessary to effect excision may be
the long axis of the bone, which will permit it to b
sufficiently for operation in cases of caries, necros
cision of either of the articular extremities. When
is the seat of a morbid growth, an elliptical incisio
employed.

OPERATION.—The patient should be placed in th
bent position, with the shoulder of the affected side
and drawn outward. In caries or necrosis, an
should be made over the anterior border, dividing t
to the bone. These with the periosteum should be s
with the elevator, and in caries, the diseased bone s
gouged out with the chisel. In partial excision for
the bone can be divided with the chain saw, metaca
or pliers, and the dead portion removed (Fig. 469).

the entire bone is to be removed, disarticulation should be effected at the acromio-clavicular junction, the coraco-clavicular ligaments severed, the bone lifted from its position, and the posterior attachments carefully separated, until the sterno-

Fig. 469.



clavicular articulation is reached. The ligaments of this articulation should be carefully divided with a probe-pointed bistoury and the bone released. The hemorrhage which follows the removal of the bone is usually slight, and may be easily controlled by pressure and douching with hot water.

Excision of the clavicle for morbid growths is frequently a very serious operation, owing to the intimate relations assumed by the growths to the structures lying posterior to the bone. A very careful dissection is necessary to avoid inflicting injury upon the subclavian vein, lymphatic or thoracic duct, and possibly the phrenic nerve. Great care should be taken to prevent the entrance of air into the large

veins which may be divided; a double ligature sh
plied before section or compression made by hæm
ceps. All appliances for checking and controlling
should be at hand, and the handle, in preference t
of the knife should be employed in separating
from its attachments. After removal of the bon
should be provided for, the wound closed by
sutures, antiseptic dressings applied and retained
by the Velpeau bandage.

In removal of the bone for necrosis, reprodu
place, the entire bone having been reproduced i
reported. Where excision is performed for morbi
this does not occur. The functions of the arm are
if any impaired after removal of the bone.

Scapula.—SURGICAL ANATOMY.—The sca
pies the posterior and lateral aspects of the thora
the first and eighth ribs, and is held in position
which attach it to the vertebral column and occi
as well as to the walls of the thorax, the cla
humerus. These muscles are attached to its an
posterior surfaces, its borders, the spine, and
cesses. It articulates by the acromion process
clavicle, and by its head with the humerus.

The vascular supply to the bone is derived from
scapular artery, which crosses the supra-scapular
and is distributed to the supra-spinous fossa and
process—the posterior scapular, a branch of the tra
colli, distributed to the posterior border of the bon
subscapular, which supplies the subscapular fossa
off a branch, the dorsalis scapulæ, to the infra-spin

Excision of a portion, or of the entire scapula

required for caries, necrosis, gunshot wounds, and morbid growths. The latter, very frequently of a malignant character, involve the entire bone, assuming collossal proportions, and demanding, in some instances, for their extirpation, removal of the entire upper extremity.

The lines of incision vary according to the character and extent of the operation. In excision of the acromion process or spine for caries or necrosis, a straight incision over the part will suffice to expose it and permit of its removal. When the entire bone is necrosed, a subperiosteal operation may be performed, the bone being exposed by two incisions, one extending the whole length of the posterior border and the other along the spine, beginning at the acromion process and terminating at the base, where it joins the posterior incision. In the removal of the bone, when the seat of large morbid growths, a T-shaped incision may be employed, the horizontal portion extending along the upper border of the growth, the vertical crossing it and terminating at the lower border.

Operation.—The patient, placed in the recumbent position, is turned upon the sound side and the body inclined forward. In cases of caries or necrosis involving the spine with the acromion process, the parts can be exposed by an incision carried from the acromio-clavicular junction backward over the spine to its base. The skin, fasciæ, and points of attachment of the trapezius and deltoid muscles with the periosteum should be carefully separated from the surface of the bone, and the gouge or chisel employed to remove the caries. If the spine is necrosed and the acromio-clavicular articulation is intact, the ligaments of the joint with the coraco-acromial should be severed and the dead portion removed, or if the acromial end of the clavicle is implicated,

it should be released by dissection and
pliers or saw. When the entire bone is i
subperiosteal resection should be performe
incisions as above described—one along th
and another over the spine from the acromi
base, joining the first. These flaps should
the overlying tissues and periosteum raise
with the elevator from the supra- and infra
and then the posterior border from the super
rior angle, released. The bone should now be
and the subscapular muscle with the perioste
from the subscapular fossa freeing at the same ti
rior and inferior borders. The bone should n
upward and outward, and, if the disease permits
divided with the pliers leaving the glenoid fossa a
process—otherwise, the ligaments of the shoulder-j
be divided as well as the structures attached to th
process, and the entire bone removed. If the bone
allowed to remain until completely detached by th
action, the muscular attachments can be removed
periosteum.

When the scapula is the seat of a large morbid
the T-shaped incision should be employed to exp
tumor, from the surface of which the tissues should b
fully dissected. If the integument is involved in the g
an elliptical incision, over the surface or about the base
tumor, directed obliquely from the point of the shoulder
vertebral column, should be made. As the mass is care
dissected from its position the various muscular attachm
should be divided as they are reached. If the disease
not extend beyond the neck of the bone, this with the ac
mio-clavicular articulation should be severed. When t

outer end of the clavicle and the shoulder-joint are involved, the incision should be carried over the clavicle and in front and behind the shoulder-joint to the anterior and posterior borders of the axilla, the bone divided at a point beyond the disease and the arm removed with the growth. In performing this operation, the greatest caution should be exercised when the region of the shoulder-joint is approached, and it becomes necessary to sever the vessels of the axilla in removing the arm. The dissection should be made from below upward, the tumor be turned up toward the neck and the axillary artery, if possible, isolated and surrounded with a ligature. The arteries distributed to the scapula should be ligatured as they are divided, or compressed with the hæmostatic forceps until completion of the operation. In this operation, as in that upon the clavicle, precaution should be taken against the entrance of air into the divided veins.

Hemorrhage having been controlled, drainage tubes should be inserted, if necessary, the wound closed by interrupted sutures, and antiseptic dressings applied and confined in position by a broad roller or spica bandage of the shoulder. The arm should be supported at a right angle in a sling.

After removal of the scapula the functions of the arm are not very greatly impaired. Of the various movements that of abduction is alone destroyed.

The mortality following total excision of the scapula is very slight, and the operation is found to be attended with less mortality than that for partial removal. Excision performed for malignant growths gives a large mortality and, as a rule, the operation should not be performed. Prof. Gross quotes the report of Prof. Adelmann in which the results in 261 excisions of the scapula are given, 66 of which were total and 195 partial. Of the total excisions, 22 were

traumatic, with a mortality of 27.2 per cent., an
logical with a death-rate of 19 per cent., the le
being unknown. Of the 195 partial operatior
traumatic, with a mortality of 26.3 per cent. ar
cent. in those performed for disease.

Humerus. — Shoulder-joint. — SURGIC
OMY.—The shoulder-joint is formed by the recep
head of the humerus into the glenoid fossa on t
the scapula. The capsular ligament, re-infor
coraco-humeral, incloses the joint through which
long tendon of the biceps muscle from its point
the upper border of the glenoid fossa, covered b
tion of the synovial membrane. The deltoid r
rounds the joint in the greater part of its extent,
on the outer side, in front and behind. Behind, the
infra-spinati, with the teres minor muscles, are i
relation with the joint as they pass to their point
tion into the greater tuberosity of the humerus. I
to the inside, the sub-scapularis, the coraco-hu
short head of the biceps are in close relation with
The axillary artery and vein, with the nerves of t
plexus, pass obliquely along the outer boundary o
lary space. The anterior and posterior circumfl
given off from the third portion of the axilla
curve backward and are distributed to the delt
the neck and head of the humerus, and the
joint. The anterior artery gives off a branch whi
in the bicipital groove to the joint, whilst the poste
around the neck of the humerus and by its bran
tomoses with the supra-scapular, acromial tho
anterior circumflex arteries. The upper and lowe

of the circumflex nerve, one of the divisions of the posterior cord of the brachial plexus, follow, in general, the distribution of the arterial branches to the joint.

The *conditions* for which excision of the shoulder-joint is performed are caries and necrosis, gunshot injuries, compound comminuted fractures, old unreduced dislocations in which severe pain is produced by pressure upon the axillary nerves, removal of the head of the bone in intra-capsular fracture when necrosis and suppuration have occurred, benign tumors involving the head of the humerus, and chronic rheumatic arthritis. In the majority of instances it is found that the disease is limited to the head of the humerus requiring excision of this part alone; in shot injuries, the head of the scapula, with the coracoid and acromion processes and the outer end of the clavicle, may be implicated and demand removal.

The *incisions* which have been employed for exposing the joint are various, embracing the straight or longitudinal, curvilinear, U-, H-, T-, L-, and V-shaped. Of the different forms, that which inflicts the least injury upon the deltoid muscle and overlying tissues and affords, at the same time, ample exposure of the joint, is the longitudinal, beginning just beneath the extremity of the acromion process and carried downward in a straight line to near the point of insertion of the deltoid muscle, measuring some five inches in length.

OPERATION.—The patient should be placed in the recumbent position with the shoulder projecting beyond the edge of the table. The knife should be entered below the acromion process, the point being carried to the bone and the incision made five inches in length dividing the fibres of the deltoid muscle. The tissues being separated from the

bone to a slight extent with the handle of the
vator, should be held apart by the retractors
rotated inward so as to permit division of the i

Fig. 470.

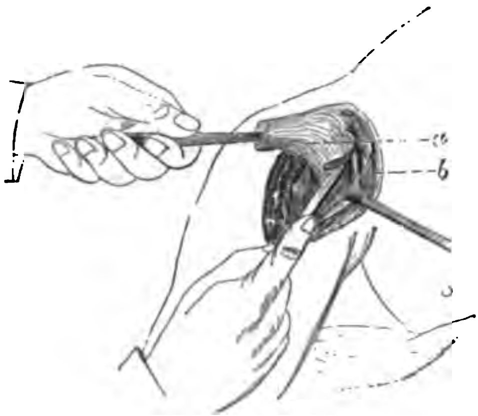
supra-
nati an
muscles
er tuber
rotated
order th
tion of t
laris mu
lesser tu
be sev
long ten
biceps m
now be carefully dissected from its position in
groove and beneath the capsule of the joint, an
the way. If not destroyed by disease,
should now be divided and the head of the
through the opening, the arm being carried fo
leather or wooden shield being placed beneath t
bone, the saw is applied and care is taken to m
tion beyond the line of the disease (Fig. 470).
may be divided with the chain saw, and disartic
effected of the diseased portion (Fig. 471). I
fossa, clavicle, coracoid, or acromion processes a
the incision may be extended and the disea
removed by the pliers or chain saw. Disease o
fossa may be removed by the chisel or gouge a
of the head of the humerus.

Subperiosteal resection may be performed by
capsule, after the preliminary incision, and with

[redacted]

detaching the insertions of the muscles into the greater and lesser tuberosities with the periosteum, lifting the tendon of the biceps from the groove, projecting the bone through the opening in the tissues and dividing it with the saw.

Fig. 471.



The divided branches of the circumflex arteries should be ligatured if required, the wound thoroughly cleansed by douching with a warm antiseptic lotion, a drainage tube introduced so as to traverse the entire length of the wound (Fig. 472), the ends appearing at the upper and lower angles, and the edges approximated with sutures. Antiseptic dressings should be applied and retained by loose turns of the spica bandage of the shoulder, a pad placed in the axilla and the arm supported in a sling or by the third bandage of Desault, the object being to carry the upper extremity upward and bring it in near apposition with the glenoid fossa.

The amount of bone to be excised varies in accordance

with the nature of the disease, it being de
instances to make the section beyond its li

Fig. 472.

ence has shown that from f
in exceptional instances,
inches may be removed
tions of the arm very lit
paired as a result. Amp
rule, to be resorted to
where one-half or more
demands removal, as the
to be useless when excisio
in these cases. In necr
this rule does not apply
reproduction is sufficient
vent great impairment of

Repair after Excision.
weeks are required to ac
ing, and from three to four months before
process has advanced sufficiently to permit u
In cases in which the periosteum has been
reproduction occurs, and the functions of the
served to a great extent. Where this has not
movements of the arm have not, in some i
greatly impaired.

The *mortality* rate after excision of the sho
all causes is very slight. The tables of Dr. C
rate at 34.70 per cent. for gunshot injuri
analyzed by Dr. S. W. Gross, for similar inju
cent; those of Dr. Hodges 23 per cent
operations and 38 per cent. in secondary opera
ion for disease in 50 cases yields a rate of 16 p
tables of Dr. Culbertson show that the grea

attends the operation when performed during the *intermediary* or period of traumatic or inflammatory fever, reaching, in these instances, as high as 50 per cent.

The mortality rate after excision of this joint exceeds that after amputation, the average in the former being 30 per cent., according to the tables of Culbertson, and 28.5 per cent. in the latter, according to the tables in the Surgeon-General's Report prepared by Dr. Otis.

Humerus.—Shaft.—SURGICAL ANATOMY.—The shaft of the humerus is that part included between the upper and lower extremities, cylindrical in the upper half and flattened and prismatic below. The musculo-spiral groove traverses the centre of the external border and passes across the external and posterior surfaces obliquely forward and downward.

Below the surgical neck of the humerus the shaft is covered on the outer side and behind by the deltoid and triceps, and on the front and inner side by the coraco-humeral, biceps, triceps, and brachialis anticus muscles.

On the inner side of the arm above, between the coraco-humeral, biceps, and triceps, and below, between the biceps, brachiali anticus, and triceps muscles, the brachial artery, with the median nerve, pass. The ulnar nerve diverges from the median in its course, leaving the brachial artery at the middle of the arm, and from this point it descends to the groove between the internal condyle and olecranon process, resting upon the posterior surface of the former at the elbow. The superior profunda artery and musculo-spiral nerve occupy the musculo-spiral groove and descend on the outer side of the arm, between the brachialis anticus and supinator longus muscles, to the front of the external condyle.

Excision of the shaft of the humerus may be re
necrosis, gunshot wounds, and ununited fracture.
fractures, the experience in military campaigns has
more favorable results follow removal of the deta
ments alone than when the more formal operation
of the ends of the upper and lower fragments is
Favorable results have followed excision in cases
arthrosis, especially when performed under anti
thods. When performed for necrosis of the shaf
gives the most favorable results.

The *incision* employed in removing the shaft
made on the outer side of the arm, beginning ab
interspace between the biceps, deltoid, and tricep
minating below between the biceps and brachial
following in the entire incision the external bor
biceps. Care should be taken, in the lower part
sion, to avoid carrying the knife between the brach
eus and supinator longus muscles, where the bif
the musculo-spiral nerve into the radial and poste
osseous occurs, and which may be wounded.

OPERATION.—The patient being in the recum
tion, and the arm supported by assistants or pl
firm pillows, the incision should be made along th
border of the biceps muscle as indicated above, an
carried to the bone dividing the periosteum. This
should be carefully elevated, reflected, and the dis
divided with the chain saw, if necessary, and rem
gunshot fractures, the detached fragments should
removed, those which are partially free being
remain with the hope that they may become co
In ununited fractures, the ends of the fragments

excised to a slight extent and, after adjustment, sutured by wire, if necessary.

After excision, the hemorrhage, which is usually slight, should be controlled by torsion or ligature, the wound douched with a warm antiseptic solution, the periosteum replaced, and the edges of the incision approximated by suture. A drainage tube having been introduced, antiseptic dressings should be applied, and the arm placed upon an internal angular splint, secured in position by a roller and supported in a sling.

Very favorable results have followed excision of the humerus for necrosis, the entire bone having been removed in a number of instances with success. In a few cases the humerus, with the upper portions of the ulna and radius, has been successfully excised. In one remarkable case by Prof. v. Langenbeck, the humerus, radius, and ulna were removed at different intervals and a serviceable limb obtained.

The retention of the periosteum, in these cases, is followed by bone reproduction to such an extent as to replace the original structure. The mortality rate following excision in gunshot fracture is more favorable than amputation for the same condition.

Humerus, Radius, and Ulna.—Elbow-joint.—SURGICAL ANATOMY.—The elbow-joint is formed by the lower extremity of the humerus, and upper extremities of the radius and ulna, and is surrounded by the triceps muscle behind, brachialis anticus, and tendon of the biceps in front, common origin of the flexor and extensor muscles of the forearm on the inner and outer surfaces. In front, in the bend of the elbow, the brachial artery with its veins, the radial and ulna arteries, and the median and musculo-spiral

63*

nerves are placed. These structures are separat
joint by the brachialis anticus, and supinator bre
upon which they rest. The ulnar nerve lies up
terior surface of the internal condyle. The vasc
of the joint is derived from the superior profun
profunda, and anastomatica magna of the brachia
radial recurrent and anterior and posterior ulna
arteries.

Excision of the elbow-joint may be demande
pound comminuted fractures, compound and c
dislocations, caries, necrosis, and gunshot injuries

Various *incisions* have been employed to expose
lation, as the H- and T-shaped incision. T
interferes least with the fibres of the triceps muscl
poses the parts fully, is the longitudinal, which sho
four inches over the posterior surface of the jo
position of the ulnar nerve upon the back of the i
dyle is to be borne in mind in the section of the
to expose the joint.

Operation.—The body of the patient should b
toward the sound side and the affected arm suppo
firm pillows. The incision should be made over t
ior surface of the joint to the extent of four inches
described, cutting through the fibres of the tricep
and its tendon. The tissues, with the periosteum
eurosis of the triceps upon the outer portion of the
should be raised with the elevator and held by a
over the external condyle. The tissues upon the i
should likewise be raised and placed over the interna
great care being exercised in exposing and lifting
nerve out of its position in the groove upon the posteri
of the inner condyle. It is covered by a dense fibrous

which should be carefully opened with the grooved director and the nerve held out of the way by a blunt hook. The parts being exposed, the olecranon process should be divided with the pliers and the lateral ligaments severed with the probe-pointed bistoury. The arm should now be flexed and an effort made to project the bones through the wound, this movement being facilitated by detaching the soft structures carefully with the elevator (Fig. 473). The shield being placed beneath the projecting ends, they should be divided by the saw, that portion only removed which is injured, or in a state of disease. It is desirable always, when possible, to limit the section to the articulating surfaces; the coronoid process of the ulna, at the base of which the brachialis anticus is attached, and the tubercle of the radius into which the biceps muscle is inserted should be preserved, retaining by this procedure the important function of flexion.

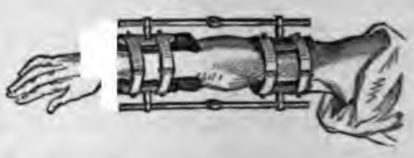
Fig. 473.

Hemorrhage having been controlled, the wound should be thoroughly washed out, a drainage-tube introduced, the edges approximated by suture, antiseptic dressings applied, and the limb placed either upon an internal angular splint, in a tin or felt trough or a plaster bandage with a metal bracket (Fig. 92), or with an opening arranged so that dressings may be applied without disturbing the limb. Comfort

may be afforded by suspending the limb in the spl
apparatus of Mr. Heath may be employed (Fig. 4

Some difference of opinion has existed among
with regard to the relative dangers of complete a

Fig. 474.



excisions of the elbow-joint, the belief having b
tained that the latter were attended with more ris
former and should not be practised. Experience
that partial excisions may be performed with saf
ease, whereas in gunshot injuries and traumatic
of recent origin complete excision should be empl

As it is desirable to maintain movement in the
ends of the bones should be kept separated in ord
vent bony anchylosis and that a fibrous band of
form. It is also desirable that the fibrous band
short as possible in order to give increased pow
arm.

The tables prepared by different authors show th
of the elbow-joint gives the most favorable result
from 10.87 to 23.05 per cent.; those for shot inju
23 per cent.; for other injuries, 15 per cent.; for d
to 12 per cent. In gunshot wounds, primary oper
much more favorable than secondary.

Radius and Ulna.—Shaft.—SURGICAL
—The anterior and posterior surfaces of the forear

ered by the pronators, flexor, and extensor muscles, and the radial region by the supinator longus and extensors of the thumb. The radial and ulnar arteries pass along the outer and inner borders of the forearm, in a line from the bend of the elbow to the styloid processes. The interosseæ arteries run upon the anterior and posterior surface of the interossoeus membrane. The radial, median, and ulnar nerves lie upon the outer, middle, and inner portions of the anterior surface.

Excision of the shafts of the radius and ulna may be required for necrosis, gunshot fracture, ununited fracture, and morbid growths.

The bones may be easily exposed by longitudinal incisions, care being taken to avoid injury to the bloodvessels and

Fig. 475.

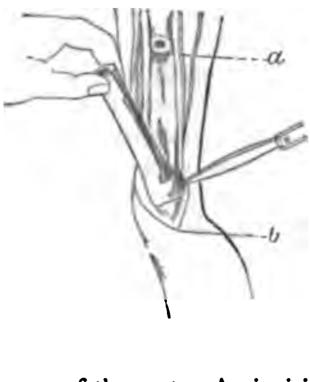
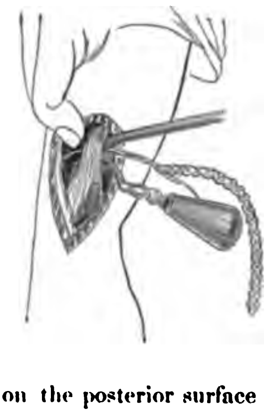


Fig. 476.



nerves of the part. An incision on the posterior surface of the forearm, along the border of the supinator longus muscle, will reach the radius without interfering with any important structures (Fig. 475). To expose the ulna the incision

quired.
the chisel
to be excis
The hemorr
controlled b
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In excision
duction of bone
limb. The rep
nor in that of o
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a rule, very fav
fractures nor for p
In a number of
amputation has bee
Gross give very fav
tised for gunshot i
per cent. Excision
tality than that of the

are placed upon the anterior and posterior surfaces of the joint. The radial and ulnar arteries cross the articulation in passing into the hand to form the superficial and deep palmar arches, the former winding backward around the outer side of the carpus and the latter passing in front to the radial side of the pisiform bone. The posterior carpal branch of the radial, with the anterior and posterior carpal branches of the ulnar, are distributed to the articulation. The articular branches of the ulnar in front, and posterior interosseous nerves behind, supply the joint. The intimate relations to the articulation of the various tendons which pass in front and behind, render excision of the joint very difficult. The position of these structures is to be borne in mind in order to avoid inflicting injury upon them.

Excision of the wrist-joint is required in cases of arthritis, necrosis, and gunshot injury. Owing to the peculiar formation of the articulation, disease and injury are usually not limited to the bones entering into the formation of the joint proper, but invade the ulna and inter-articular cartilages, as well as all of the carpal bones, and even sometimes attack the bases of the metacarpal bones.

Various incisions have been employed to expose the joint as the H, L, quadrilateral, and linear incision upon the borders of the articulation. The objection to those which are carried across the surface is the division of the tendons in such a manner as to interfere with their future functions. The linear incisions should be made on the radial and ulnar borders, the former beginning an inch and a half above the styloid process of the radius and terminating half an inch beyond the base of the metacarpal bone of the thumb, care being taken to avoid wounding the radial artery as it passes beneath the extensor tendons of the thumb. The incision

on the ulnar border should begin just above the styloid process of the ulna and extend downward to a point half an inch below the base of the metacarpal bone of the little finger.

OPERATION.—The patient having been placed under the influence of an anæsthetic and the forearm and hand supported, the incisions above described should be made on the radial and ulnar borders of the joint. The tissues on the posterior surface, including the tendons, should be carefully detached from the radius and bones of the carpus, and the radial artery lifted from its position and held out of the way by a blunt hook. The tissues on the anterior surface of the joint should be detached, a straight sharp-pointed bistoury being passed from the ulnar to the radial side in close contact with the bones and carried downward until it strikes the pisiform bone which should be separated from its articulation with the cuneiform. The detachment of the pisiform bone permits the insertion of the tendon of the flexor carpi ulnaris into the base of the fifth metacarpal bone to remain undisturbed. The lateral ligaments should now be divided and the ends of the radius and ulna projected through the wounds on the radial and ulnar sides, and removed *at the same level* by the chain saw or pliers. The carpus can now be forced through the wound, and the dorsal ligaments, uniting the two rows of bones, divided with the probe-pointed bistoury and separated with the pliers, removing the upper row entirely or separately with the bone forceps. In the same manner the second row may be detached from the metacarpal bones and with them, if necessary, the bases of these bones.

In this operation, the position of the radial and ulnar arteries and the deep palmar arch should be remembered.

In the operation known as Mr. Lister's, two incisions are

made, and it is performed in the following manner, as quoted by Prof. Ashhurst. The *radial* incision begins about the middle of the dorsal aspect of the radius, on a level with the styloid process, and passes downward and outward toward the inner side of the metacarpo-phalangeal articulation of the thumb, but, on reaching the line of the radial border of the metacarpal bone of the index finger, diverges at an obtuse angle and passes downward longitudinally for half the length of that bone. An *ulnar* incision begins two inches above the end of the ulna and immediately in front of that bone, passes downward between the flexor carpi ulnaris and the ulna, and terminates at the middle of the palmar aspect of the fifth metacarpal bone. The only tendons necessarily divided by this method are the extensors of the wrist. The trapezium is to be separated from the rest of the carpus by cutting with the bone forceps before the ulnar incision is made, but is not to be removed till a later stage of the operation; similarly, the pisiform bone is to be separated and left attached to the flexor carpi ulnaris, while the hook of the unciform bone is also severed and left attached to the annular ligament. The tendons being then raised before and behind the wrist, the anterior ligaments of the joint may be divided and the cutting pliers introduced first between the carpus and radius, and afterward between the carpus and metacarpus. Its connections being thus divided, the whole carpus except the trapezium and pisiform may be pulled out with a pair of strong forceps. The articulating extremities of the radius and ulna can now be made to protrude through the ulnar incision and can be retrenched as much as may be thought desirable, the ulna being sawn obliquely so as to retain the styloid process and thus lessen the tendency to subsequent displacement. The

articulating ends of the metacarpal bones are then protruded and excised, and the operation completed by dissecting out

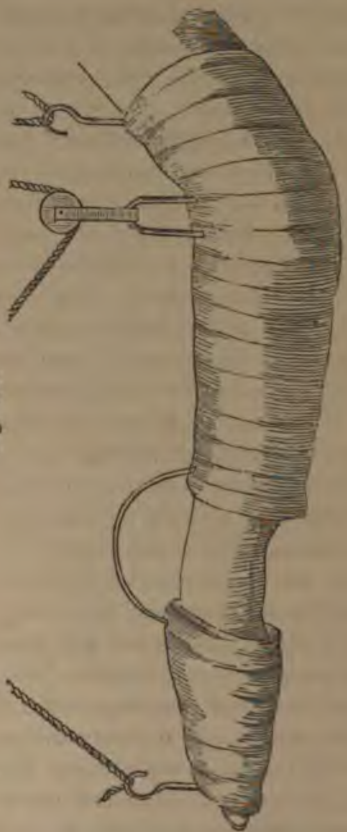


Fig. 477.

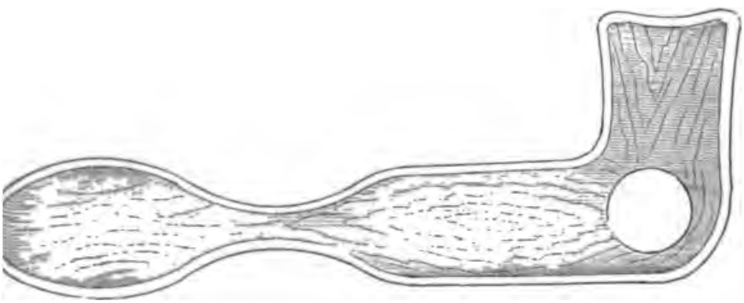
Fig. 478.

the trapezium, and by removing the articulating surface of the thumb, and as much of the pisiform and hook-like process of

[redacted]

the unciform as may be found necessary. When the operation is completed a drainage tube should be passed through the wound, the incisions sutured, antiseptic dressings applied, and the forearm and hand placed upon a Bond's splint with the sides removed, or an anterior palmar splint with a block of wood upon it for the hand to grasp, and, if necessary, extension may be maintained by weights and pulley. A plaster bandage with an iron frame for support (Figs. 477, 478), or an internal angular splint may also be employed

Fig. 479.



(Fig. 479). Passive motion of the thumb and fingers must be made to prevent adhesions of the tendons whereby great impairment of function might result.

The great difficulties which attend excision of the wrist-joint and the complicated structure of the articulation, render the results frequently unfavorable as to the usefulness of the hand. The mortality rate for all conditions is nearly 30 per cent. The expectant plan of treatment in shot wounds gives a rate of 7.6; amputation through the forearm 9.6 per cent.

Carpus, Metacarpus, and Phalanges.—S

ANATOMY.—The anterior and posterior surfaces of pus are covered by the flexor and extensor tendor muscles of the carpus and fingers; the palmar surfa hand is occupied by the muscles proper of the thu finger and the lumbricales and interossei; on the d face the extensor tendons of the carpus, the fingers sal interossei muscles are placed. The arterial a supply to the carpus has been described in connec the operations upon the wrist-joint. The metaca phalanges are supplied in front by branches from and superficial palmar arches and behind by branc the posterior carpal arch. On the palmar surface t arteries at first are placed superficial to the flexor as they pass forward to the clefts of the fingers, acc by the digital nerves, they lie between them. On of the fingers the digital arteries lie beneath tl nerves. The branches from the posterior carpal radial artery pass forward on the dorsum to the ti fingers, running in connection with the extensor The median and ulnar nerves supply the palm branches to the fingers in connection with the arter radial and ulnar nerves supply the dorsal surface of carpus and phalanges.

Excision of the bones of the carpus, metacarpus, langes may be required in cases of compound co fractures resulting from gunshot or other injury, and

The bones of the carpus, metacarpus, and phala be exposed and removed by a longitudinal or curve the former being preferable. The incision should in the line of the tendons upon the dorsal surface tween them and the arteries (Fig. 180).

[redacted]

Fig. 480.

OPERATION.—In cases of necrosis, accompanied by sinuses, the openings may be enlarged, the periosteum detached, and the dead bone removed with the forceps or by chisel and gouge. In shot fractures the detached fragments alone should be removed. In all instances the periosteum should be preserved and replaced, with the view to secure reproduction of bone. After operation the wound should be cleansed, drainage by horse-hair or catgut threads secured, antiseptic dressings applied, and the forearm and hand placed upon a splint with a block for the palmar surface of the hand to rest upon.

Fig. 481.

In excision of the metacarpal bone of the thumb the incision should be straight and made at the line of junction of the palmar and dorsal surfaces (Fig. 481).

In some instances very good results follow excisi bones of the carpus, metacarpus, and phalanges, esp those in which the expectant plan has been pursue dead bone detached by suppurative action. Rep of bone occurs usually in these cases and supplies a stitute for the original bone. Excision should no formed upon the first and second phalanges, as after repair has taken place is useless and a source ance. In disease or injury of the third phalanx, tion is eminently proper. In all operations upon its important functions should be remembered and tive surgery, whenever it is possible, employed.

LOWER EXTREMITY.

Femur.—Hip-joint.—SURGICAL ANATO hip-joint is formed by the acetabulum and head of and is surrounded by muscles, the larger numbe having relations with the joint being inserted greater and lesser trochanters. Branches of the sciatic, internal, circumflex, and gluteal arteries buted to the joint, while the femoral artery and v front of it separated from the capsule by the psoa tineus muscles where their edges approximate. is supplied by the branches of the sacral plexus, gr obturator and accessory obturator nerves. The ant nerve lies in front, to the outside of the femoral v the great sciatic nerve lies behind the joint and b trochanter major and tuberosity of the ischium.

The conditions which require excision of the gunshot injuries and caries and necrosis develope nection with coxalgia.

Various incisions have been employed to expose the joint as the T- and V-shaped, the crucial, semilunar, curvilinear, and longitudinal. Of these the straight or curvilinear incision will afford ample space in excision of the joint.

Operation.—An anæsthetic having been administered, the patient should be turned upon the sound side and the straight or curvilinear incision made, beginning one inch and a half above the summit of the great trochanter, carrying it downward along the posterior border and terminating two inches below the base of this eminence; the wound should be from five to six inches in length and include section of all of the tissues to the bone; a transverse incision should now be made in the periosteum, and, if possible, this membrane, with the points of insertion of the muscle into the greater and lesser trochanter should be detached by the elevator. In cases of chronic inflammation where the periosteum is thickened, this may be readily accomplished, otherwise it is quite impossible to effect this separation satisfactorily. If the points of insertion of the muscles are not detached with the periosteum they should be divided with the probe-pointed bistoury. The position of the head of the femur having been ascertained by the finger, and the capsular ligament having been made tense by abducting the limb, it should be incised with the probe-pointed knife on its anterior and lower surface; abduction, with external rotation, of the limb will dislodge the head of the femur, so that section of the ligamentum teres can be made and disarticulation completed. The bone can now be protruded through the wound, care being taken that it is not fractured in the effort, the wooden shield slipped beneath it and section below the base of the trochanter made by the saw. If deemed desirable or more convenient, the bone may be

...g indicated by
ligament to the
junction of the mi
the tendon of the a
popliteal artery pa
hind the knee-join
head of the femur, a
the bone as it passe
lies in front, to the
course from Poupa
profunda femoris ari
common femoral, fr
ligament, and passes
thigh terminating at t
vein occupies a posi
between the two laye
slightly to the inside
The anterior crural
sheath above and dist
front and inside of t
passes down on the p
beneath the biceps and
Excision of the fem
compound comminu...

OPERATION.—In excisions performed for necrosis, the openings into the sinuses may be enlarged in a direction to avoid wounding any important bloodvessel or nerve, the involucrum cut thorough with the pliers, and the sequestrum extracted with the bone forceps. In compound comminuted fractures, the detached fragments should be removed through the wound in the soft tissues. Excision for pseudarthrosis should be cautiously performed, a slight portion being removed, and the ends of the cut surfaces wired together.

GREAT TROCHANTER.—Excision of this eminence may be performed by making a linear or slightly curved incision over its position. If the muscular attachments to the process remain, they should be divided and the diseased portions removed by the chisel, gouge, or pliers. The wounds after these operations should be drained, edges approximated, and dressings applied as in other excisions. In excision in compound comminuted fractures and for pseudarthrosis, the limb should be supported upon a suitable splint, by sand bags or by a plaster bandaage.

Tibia.—Knee-joint.—SURGICAL ANATOMY.—The condyles of the femur, above, the head of the tibia, below, with the patella in front, take part in the formation of the knee-joint. The tendon of the quadriceps extensor femoris, enveloping the patella, passes in front of the joint to its insertion in the tubercle of the tibia. On the outside, the tendon of the biceps muscle passes to the head of the fibula where it is inserted. On the inside the sartorius, gracilis, semitendinosis and semi-membranosis are placed, their points of insertion being in the internal tuberosity and anterior surface of the tibia. Behind, the two heads of the gastrocnemius, with the plantaris and popliteus muscles rest. On the surface of

branch from tl
anterior crural, (
the articulation.

Excision of th
chronic articular
gunshot injuries (

The **H**, **U**, cr
employed to expo
the most satisfact
duced, and is mad
edge of the base (
patella, to the poste
Through the angles
made, drainage can

OPERATION.—Th
position, if the dise
made as above ind
vein on the inner sid
vided, the flap is rais
crucial ligaments sev
knife to avoid woundi
possible injury upon
should now be dissec

The ordinary saw may be employed, the wooden spatula being placed beneath the bones while section is made (Fig. 483.)

The amount of bone removed will depend in each case upon the conditions for which the operation is performed. In all cases where it is possible, more *especially in the young*, before union between the epiphysis and shaft has occurred, the point of section of the bone should fall some distance within the epiphyseal line, not approach too near to it nor extend beyond it. This injunction is to be particularly observed in section of the femur, in order that the subsequent growth of the limb may not be interfered with; it is also important, in connection with section of the tibia, but in less degree. The *direction* in which the section is made should also claim attention, in order that subsequent deformity may not occur. This may be accomplished by making the section parallel with the articular surfaces, or, as suggested by Billroth, in a "plane which, as regards the axis of the femur, is oblique from behind forwards, from below upwards, and within outwards." The section of the tibia should be made "transverse to the long axis of the bone, with a slight antero-posterior obliquity."

Fig. 483.

If the hamstring tendons are in a state of contraction and prevent full extension of the limb they should be divided.

The removal of the patella is deemed desirable, especially when the excision is performed for disease. In operations

cases, to re

The hemorrh
may be controll
be thoroughly
tions, a drainage
ends may appear
and antiseptic dr
after the operati
placed in accurat
by drilling and in
mobility of the lim
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prefers a plaster d
is still under the i

the bandages should be cut over the front of the limb to prevent undue pressure, and above and below the knee to form sections, which may be raised and lowered so as to permit dressing of the wound without disturbing the limb. The limb may now be suspended by strips of muslin attached to a frame by cord and pulley (Fig. 484). The bracketed wire splint of Prof. Ashhurst may be employed (Fig. 485) or that of Price (Fig. 486).

Fig. 485.

In the absence of splints of this form the long fracture box may be used. Recovery, after knee-joint excision, is very slow, requiring from eight to nine months for its completion.

Fig. 486.

The results, as to the condition and function of the limb, present great varieties, as shown in the shortening of the limb, position, and character of the union, as well as its

function in supporting weight and tolerating pr
movement. The permanence of the results cann
nitely determined until some time has elapsed,
year or more. Age exerts a very marked influe
, as seen on examination of
tality-rate being highest i
er and hirty years. Gunshot injuri
rvice ery high mortality-rate, 68
c civil e 39 to 42 per cent. Ex
d eturn of from 20 to 32 per cent.; i
five and it is reduced to 16.2 per ce
ty-rate in cisions for bony anchylosi
favorable, not exceeding 25 per cent. In excisi
knee-joint, as in those of other joints, consecutiv
tion is necessary in a certain proportion of cases ;
impairment of function occurs also in some.

Tibia and Fibula.—Shaft.—SURGICAL A
—The outer portion of the anterior surface, with
and posterior surfaces of the bones of the leg, are c
the flexor, extensors, abductors, and adductors o
The anterior tibial artery descends upon the anteri
of the interosseous membrane and of the tibia, t
of the ankle-joint. The posterior tibial and its b
peroneal, pass down upon the posterior surface of th
ing upon the tibialis posticus muscle. The poste
descends to the fossa between the internal malleolus
and thence to the sole of the heel, where it divid
internal and external plantar arteries. The peron
occupies a position along the inner border of the tib
nating at the ankle-joint. The anterior tibial and
cutaneous nerves are placed on the anterior surface

the former accompanying and lying to the outer side of the anterior tibial artery; the latter lies on the fibular side of the leg and terminates in branches to the dorsum of the foot and toes. The posterior tibial nerve runs in connection with the posterior tibial artery lying to its outer side. The internal saphenous vein ascends the leg along the inner side, passing in front of the internal malleolus, and lying behind the inner border of the tibia accompanied in its course by the internal saphenous nerve.

Excision of the bones of the leg may be demanded for necrosis, compound comminuted fractures, ununited fractures, and deformity.

The bones may be exposed by longitudinal incisions made over their position; that for the tibia, upon the anterior surface or spine, and that for the fibula, upon the outer side of the leg (Fig. 487).

Fig. 487.

OPERATION.—The bones having been exposed by the incision, the periosteum should be detached, the bone divided, and the portion removed. In necrosis, the dead bone may be removed by the chisel, gouge, and forceps, and in caries, by the chisel or burr of the surgical engine; in compound fractures, the protruding portions of bone may be removed by the saw or pliers, if necessary; detached fragments, in comminuted fractures, should be picked out with the forceps; in ununited fracture, occurring in the tibia, both bones should be excised

in order to secure union. In excision of the
malleolus if possible should be preserved in order
outer support of the ankle-joint may not be rem
thus permit eversion of the foot.

been controlled, the woun
for, sutures introduced, and
ares leg should be placed in a fra
oper orded until repair occurs, s
to ma e. When repair has suffic
a p te lage may be applied, and t
to w rutches. The mortality-rat
he bones he leg is very favorable, be
per cent., as ascertained by Dr. S. W. Gross, i
injuries, and 16.8 for all conditions outside of sho
as recorded by Heyfelder.

Tibia, Fibula, and Astragalus.—Ankle
Surgical Anatomy.—The bones entering into t
tion of the joint are the tibia, fibula, and astraga
structures in relation with this joint are, in front, t
anticus, extensor proprius pollicis, anterior tibia
anterior tibial nerve, extensor communis digitorum,
tertius in order from within outward; behind, ti
ticus, flexor longus digitorum, posterior tibial ve
terior tibial nerve, flexor longus pollicis, in posi
within outward. These structures maintain the s
tions on the inner side. In the groove behind the
malleolus, the tendons of the peroneus longus and
brevis pass.

Branches from the anterior tibial and perone
supply the joint. The nerves are derived from th
tibial.

The conditions which require excision of the ankle-joint are articular disease, compound fractures or dislocations, and gunshot injuries.

The joint may be exposed, preferably, by an incision on the outer side, curvilinear in shape, beginning three inches above the end of the external malleolus, along the posterior border of the fibula, carried downward behind the malleolus, and terminating within half of an inch of the base of the fifth metatarsal bone. If the joint is extensively involved, a similar incision may be made on the inner aspect of the leg and foot, terminating at the internal cuneiform bone.

Operation.—To permit satisfactory inspection of the parts during the operation, the circulation may be controlled by Esmarch's bandage. The incision on the outside having been made as above described, the flap is dissected up, the tendons of the peroneus longus and brevis being carefully avoided. The fibula, which is exposed, may be divided with the pliers or saw, and the connections of the detached portion severed. The joint may now be inspected and the diseased portions of the astragalus and tibia removed by the chisel or gouge. If the disease is extensive, the inner incision along the tibia may be made, and the flaps carefully dissected in order to avoid injury to the structures placed on the inner side, consisting of the tibialis posticus, flexor longus digitorum, with the posterior tibial vessels and nerve. These being displaced and held away, the deltoid ligament may be detached, or the extremity of the internal malleolus divided with the pliers. The malleolus being isolated, the surfaces of the tibia and astragalus can be inspected by everting the foot strongly. The internal malleolus can be divided by passing a metacarpal or Adams saw through the wound behind the tibia, and sawing from behind forward. The articulating

surface of the astragalus may be removed in like m
if necessary, it may be dissected out and removed
An effort should be made in this operation to pr
periosteum in order to obtain bone reproduction.
of one or more vessels may be required, after
ched with warm antiseptic
ntirely through it, the edges
eptic dressings applied, and
x, the foot being carefully s
roper angle to the leg. I
r dressings may be applied
o permit of inspection and
).

The after-treatment should be conducted as in
cisions, passive motion being instituted so as to
short ligamentous union—anodynes, stimulants, to
good food being given as needed. Four to five mo
required to perfect recovery.

The mortality-rate in ankle-joint excision is abo
cent., a rate higher than that in amputations at t
which vary from 6 to 9 per cent.

Tarsus, Metatarsus, and Phalanges.—S
ANATOMY.—The tarsus consists of seven bones,
calcis, astragalus, cuboid, scaphoid, and internal,
and external cuneiform bones. They are divided
rows, the os calcis and astragalus constituting the
the cuboid, scaphoid, and three cuneiform bones th
row. The *os calcis* articulates above, with the as
and in front, by its anterior surface with the cuboi
astragalus is placed between the bones of the leg a
os calcis below, and articulates by its head with the

[redacted]

in front. The *cuboid* occupies a position on the outside of the foot, articulating behind with the os calcis, on the inside with the scaphoid and external cuneiform, and in front with the fourth and fifth metatarsal bones. The *scaphoid* is placed on the inner side of the foot, articulating behind with the astragalus, on the outer surface with the cuboid, and in front with the internal, middle and external cuneiform bones. The three cuneiform bones are placed on the inner aspect of the foot, articulating behind with the scaphoid, in front with the bases of the first, second, third, and fourth metatarsal bones, and on the outside with the cuboid.

On the anterior surface of the tarsus, the tendons of the tibialis anticus, extensor proprius pollicis, and extensor longus digitorum, with the body of the extensor brevis digitorum, the dorsalis pedis artery, and terminal branches of the anterior tibial and musculo-cutaneous nerves are placed. The tendons of the peroneus longus and brevis pass on the outer side, behind the external malleolus, and on the outside of the cuboid bone, the former traversing the sole of the foot to its point of insertion in the base of the first metatarsal bone. On the inside, the tendons of the tibialis posticus, flexor longus digitorum, and flexor longus pollicis, with the posterior tibial vessels and nerves, pass to the sole of the foot. The under surface of the tarsus is covered by a thick mass of muscular structures, composing the muscles of the plantar region, with the external and internal plantar arteries and nerves. Of the bones of the tarsus, the astragalus alone has no muscular attachments, although its surface is grooved for the passage of tendons. In operations upon the bones of the tarsus the relation of the bones, one to the other, and of the tendinous, vascular, and nervous structures,

should be borne in mind in order that they ma
injured.

The astragalus, os calcis, and scaphoid are more fr
involved in injuries and diseases than the remaini
of the tarsus, and are in consequence more frequ

ring excision, partial and
articular disease, compound
necrosis, and gunshot injuri
sed by straight or curved
ons, care being taken, in ra
o the tendons which are

OPERATION.—ASTRAGALUS.—The bone may b
reached by a semilunar incision over the outer and
surface of the ankle-joint dividing the integument a
The tendons of the extensor muscles, and dorsalis ped
on being exposed, should be held out of the way o
and the neck of the astragalus severed by strong cutti
The head of the bone being detached from the sc
removed and the body of the bone may be seized
lion-jawed forceps, and while forcible traction is
various directions the ligaments should be divided by
probe-pointed knife, which should be kept in clos
with the surface of the bone. If the bone is disi
by disease it will be necessary to remove it by the g
forceps. The articular ends of the tibia and fibul
exposed in this operation by extending the incisio
on the outer side behind the external malleolus.
of the ends may be effected by the pliers or chain
foot being moved in such direction as to expose the

Os CALCIS.—This bone may be exposed by an

across the sole of the heel, similar to that employed in Syme's amputation at the ankle-joint. The incision suggested and practised by Mr. Erichsen is preferable, as by it the wounding of important structures is avoided and the cicatrix is not exposed to pressure. The patient being in the prone position, the knife is entered three-quarters of an inch behind the tuberosity of the fifth metatarsal bone and carried backward around the heel below the position of the posterior tibial artery, the incision terminating about opposite the tuberosity of the scaphoid bone on the inner side of the foot. The incision should be made through the skin and fascia, and the tendons of the peronei muscles carefully avoided in their position on the outer side of the cuboid bone. The flap is to be dissected from the bone and reflected. A vertical incision should now be made over the tendo Achillis, joining the first, and the tissues removed from the tendon and its attachment to the os calcis severed. The interosseous ligament, uniting the os calcis and astragalus, should now be divided by carrying the knife upward over the posterior surface of the bone, which is now seized by the lion-jawed forceps and strongly retracted, while the lateral ligaments are divided. The long calcaneo-cuboid ligament is now divided, and the bone, being free, is removed (Fig. 488).

Fig. 488.

Subperiosteal excision of the bone may be performed, as practised by Ollier, the periosteum, with the tendons, being raised by the elevator.

... The internal lateral
... by strongly adducting the foo
by ... probe-pointed knife and the
removed, care being taken, in the in
side, to avoid the posterior tibial v
of the os calcis from the cuboid, and
scaphoid may now be effected and th

CUBOID, SCAPHOID, AND CUNE
bones may be excised separately or
curv
dors
(Fig
over
held
artic
rate
mov
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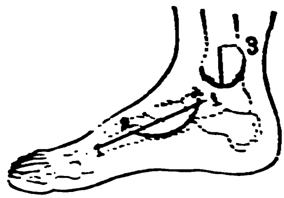
Fig. 489.



ENTIRE TARSUS.—Involvement o
tarsus in ...

ross the dorsum is made it involves division of the extensor ndons, which should, after the excision, be united by suture.

In excision of the bones of the tarsus, partial or complete, e wound should be thoroughly cleansed, a drainage tube arried through from side to side to accomplish efficient ainage, the edges of the wound approximated by sutures, ıtiseptic dressings applied, and the limb placed in the acture box or the plaster bandage. If the periosteum has een preserved reproduction of bone may occur. Recovery 'ter tarsal excisions is very slow, requiring from five to six onths. The results following excision of the bones of the ırsus are, as a rule, very favorable, both as regards the use-lness of the limb and the mortality-rate. In excisions of ie astragalus, the rate of mortality varies from 14 to 18 per ent. In excisions of the os calcis the mortality does not uch exceed 15 per cent. In operations upon the cuboid, aphoid, and cuneiform bones the rate is 14.2 per cent.

In 108 excisions of the tarsus, partial and complete, re-orded by Prof. Conner, in 45 the result was *very good*; in 3, *good*; in 6, *fair*: in 10, *failures*; in 12, *uncertain*: in , *unknown*—making the percentage of recoveries 88.89. n 11, death occurred, giving a mortality-rate of 10.18 per ent. In two excisions of the entire tarsus, performed by im, the results were most satisfactory, the patients being ble, after recovery, to walk without limp and without the d of support and to engage in the most active employments. hortening of the limb occurred to the extent of one-half to ree-fourths of an inch, and of the foot from two and a half three inches.

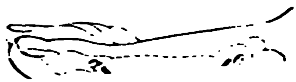
Metatarsus.—SURGICAL ANATOMY.—The metatarsal nes are placed between the cuneiform and cuboid bones

... branches, three in number
... dorsal interossei muscle
... divide into two dorsal branche
The external plantar artery forms a
the foot on the bases of the metata
between the bases of the first and se
cating branch of the dorsalis pedis,
branches, which are distributed t
second toe and the outer toes, both
the inner side of the second being s
cating branch of the dorsalis pedis ar
dorsal and plantar surfaces follow th

The conditions demanding exci
bones are caries, necrosis, compound
dislocations.

The bones should be exposed by
incisions over the dorsal surface (Fi
bloo
avoi
O
bein
...

Fig. 490.



teries of the plantar region. *Sub-periosteal* excision may be performed in cases of necrosis and other conditions. In caries, the gouge and chisel should be employed to remove the diseased bone. After the application of dressings the limb should be placed in a fracture-box. The bases of the metatarsal bones have been excised, with the bones of the tarsus, for disease implicating both.

PHALANGES.—Excisions of the phalanges are limited to those of the metatarso-phalangeal articulation of the great toe and to the bones of the third row, which can be exposed by incisions upon the plantar or lateral surfaces. In compound fractures the fragments can be dissected out and removed by the forceps. Excision of the metatarso-phalangeal articulation of the great toe has been performed in cases of necrosis.

After the application of dressings, the foot should be kept at rest, if necessary, in a plaster splint or in the fracture-box.

INDEX.

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